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Metal Treating

THE *ONLY* MAGAZINE DEVOTED EXCLUSIVELY TO THE HEAT TREATING INDUSTRY

This large, elevator, car-bottom atmosphere annealing furnace is heated by gas-fired, radiant tubes. *Photo courtesy Surface Combustion Corp.* (See page 2)

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ECONOMIC ADVANTAGES OF GAS-FIRED HEAT TREATING FURNACES

By **F. C. SCHAEFER,** Sales Mgr.
American Gas Furnace Co.
Elizabeth, New Jersey

Editor's Note: *This article was written by the author to serve specifically as a sequel to the article published in the November-December 1958 issue entitled "Economic Advantages of Electric Furnaces" by Walter H. Holcroft.*

ANY WELL-INFORMED engineer will recognize the necessity of weighing all salient factors in deciding which heat medium to use when considering new or additional heating applications.

Above all considerations in selecting a heating means, it is necessary to find a way to produce acceptable work consistently. The quality and uniformity of heat treated products has no definite relationship to any particular kind of energy or kind of furnace.

Contrary to what some would have us mysteriously believe, heat is heat, and if properly and uniformly heated, the work is satisfactory regardless of the heat source. Some of the modifying factors, often the deciding ones, are the atmosphere surrounding the work as well as the speed of heating.

Gas heating is unquestionably the most widely used heat source in the metal treating industry, and the reason for this popular selection should be closely and carefully examined.

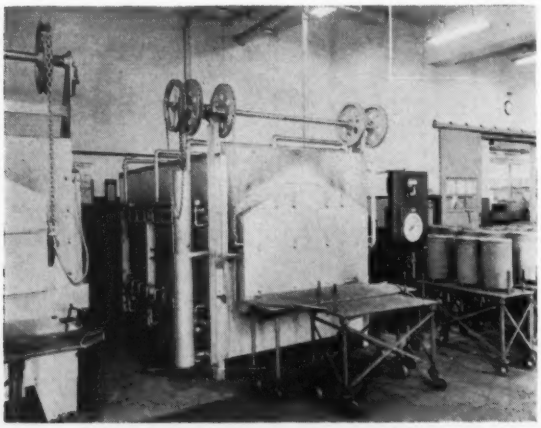


Fig. 1—A side-by-side comparison of gas and electric furnaces on identical work over a reasonable time makes possible a true evaluation. Note furnaces and carburizing pots mentioned in text.

Survey Made

In an effort to sample the deciding factors, a small informal survey was made of several leading commercial heat treaters in the East and West, as well as some plant engineers from a few large manufacturing concerns who had the most influence on furnace and fuel selection in their companies.

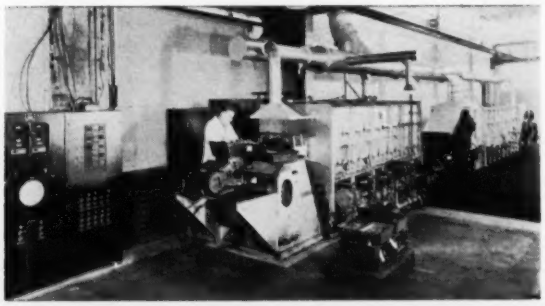


Fig. 2—A continuous, gas-fired line of equipment for hardening, quenching and tempering. Note the cleanliness possible. Vents are connected only to take away atmosphere burn-off, fumes from oil on incoming work and quench oil fumes. No connections at all have been made to take away relatively harmless flue products.

Generally speaking, the survey made clear not only that gas was the most widely used fuel but also that the reasons for the selection of gas were almost equally the lower cost of this fuel and a much lower maintenance cost. Very few oil-fired furnaces were used, but there were a few electric furnaces selected primarily for specific reasons in spite of fuel cost and maintenance cost.

One New England heat treater cited as an example a simple box-type electric furnace of reputable make built about 1946. In the six-year period up to February, 1952, he freely estimated that his concern had spent as much as 20% of the original cost of the furnace in element maintenance, not including such intangible expenses as downtime, specialized labor, etc. The furnace was converted to gas in February, 1952, and since that time no expense whatsoever has been attributable to the combustion system or the fuel. In addition to this, he also claims a lower cost of gas fuel and a considerably greater productivity rate from the furnace.

Other large industries, including makers of bearings, hardware and tools were specifically questioned,

and gas was by far the universal fuel; other heat means were very specific and definitely minor.

A New England manufacturer of chucks has documented evidence of an identical operation carried on both in a gas-fired furnace and in an electric box furnace. The application consisted of 42 carburizing pots in each furnace, 10" o.d. by 24" high, for a total weight of 6300 pounds. A stress relieving process was also carried on in the same furnaces. The gas consumption for a 10-hour preheat and a 20-hour carburizing soak was 19,600 cubic feet, which, at the current rate, cost $17.64. For the stress relieving cycle, the gas usage was 6600 cubic feet, costing $5.94. The electricity consumed at 1¾¢ per KW ran $30.00 for the carburizing and $10.00 for the stress relieving.

Thus, the combined job in the gas furnace required a fuel cost of $23.58 versus an electric cost of $40.00. Additionally, the electric furnace, according to the user, has to have a new set of elements every 18 to 24 months, whereas the gas furnace to date has not required a single burner replacement.

A commercial heat treater in the metropolitan New York area uses gas wherever he can. He recently had

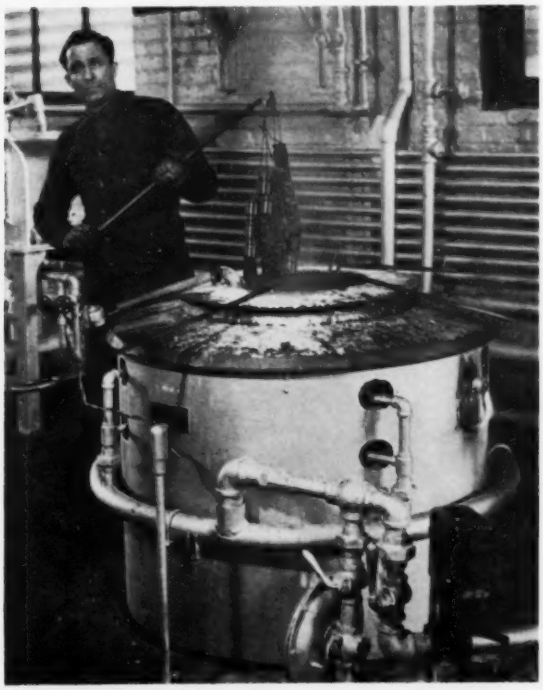


Fig. 3—Gas-fired pot furnaces are rugged and low in cost. They are well suited for tempering, case hardening and cyaniding.

to replace elements unexpectedly in a vertical electric carburizer and remarked about the comparatively large expense. From his experience, the initial cost of the gas and electric furnaces was about the same, with the gas being slightly lower. His plant area is relatively small, and primarily because of space considerations, he made a recent installation of an electric elevator

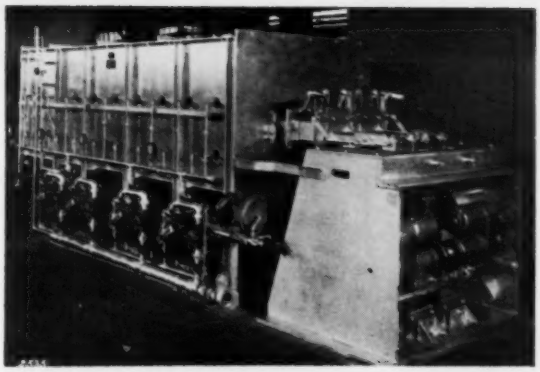


Fig. 4—Numerous small gas burners are practically noiseless, last long, are easily replaced and are convenient to arrange for most uniform heating in zones.

quench unit. He also noted the unique value of the immersion electrode-type, high speed salt bath, but most of his case hardening pots and tempering salts are gas heated. He complained of a fairly high demand charge and pointed out that there was no such charge for his gas supply.

Another interesting comment was made in connection with venting. It is commonly pointed out that gas-fired furnaces must be vented to void the products of combustion, but this commercial heat treater said that the air contamination from the oil not washed off the customers' work was by far a greater factor. Atmospheres containing large amounts of H_2 and CO used in *all* kinds of furnaces must also be vented where they are emitted from the furnace.

He conceded that electric furnaces were easier to start off, but he said that his help found no trouble in lighting off the gas units and, further, "they could tell by the sound that the furnace was lit." This emphasizes the fact that electric furnaces are noiseless, although gas units with many small burners of the total premix type are noiseless as well. Large oil fires and radiant tube units are often inclined to be noisy.

One of the largest and most progressive bearing manufacturers in the East has a large number of furnaces for carburizing, heat treating, etc., including reciprocating furnaces, rotary furnaces, conveyors and pusher-type units. They have only a few small electric units in their tool room and several specialized units purchased because of space and location and because the manufacturer whose unit they wanted made only electric units. (This last reason may have a more deciding influence than we realize.) At one time, this manufacturer had a fair number of electric carburizers, but these have subsequently been changed to gas. Here again was mentioned, without prompting, the difference in fuel cost and the maintenance factor. Electric costs here run 1¢ per KW and gas is about 9¢ per therm. Even at 50% efficiency, the gas costs about half.

Another large eastern manufacturer of small special machines has been using gas primarily, but most of his new units are electric. Careful questioning brings

(Continued on page 35)

HIGH TEMPERATURE CARBURIZING

By **H. N. IPSEN,** President
Ipsen Industries, Inc.
Rockford, Illinois

TO THOSE familiar with standard gas-carburizing practice, the proportionate increase of carbon penetration with increase in temperature is well known. However, general consensus has indicated that excessive grain growth and the related effect on physical properties and dimensional stability have limited the temperatures of carburizing to the range of 1700° to 1750° F. Furthermore, the foreshortened life of heat-resisting alloy furnace parts at elevated temperatures becomes economically unfeasible.

Obviously, the furnace manufacturer takes a keen interest in any new heating or heat treating development, and the trend toward processing at elevated temperatures has created active interest in the basic problems involved. The heat resistance of materials of construction, as well as their resistance to the effects of chemical attack, has been given close consideration by furnace users. Therefore, a desirable investigation of high temperature carburizing must be dependent upon two factors. First, there must be commercially available standard steels of analysis suitable to carburization at elevated temperatures without excessive grain growth. Secondly, there must be available practical gas carburizing furnaces capable of operating at elevated temperatures and under exaggerated conditions of enriched endothermic atmospheres.

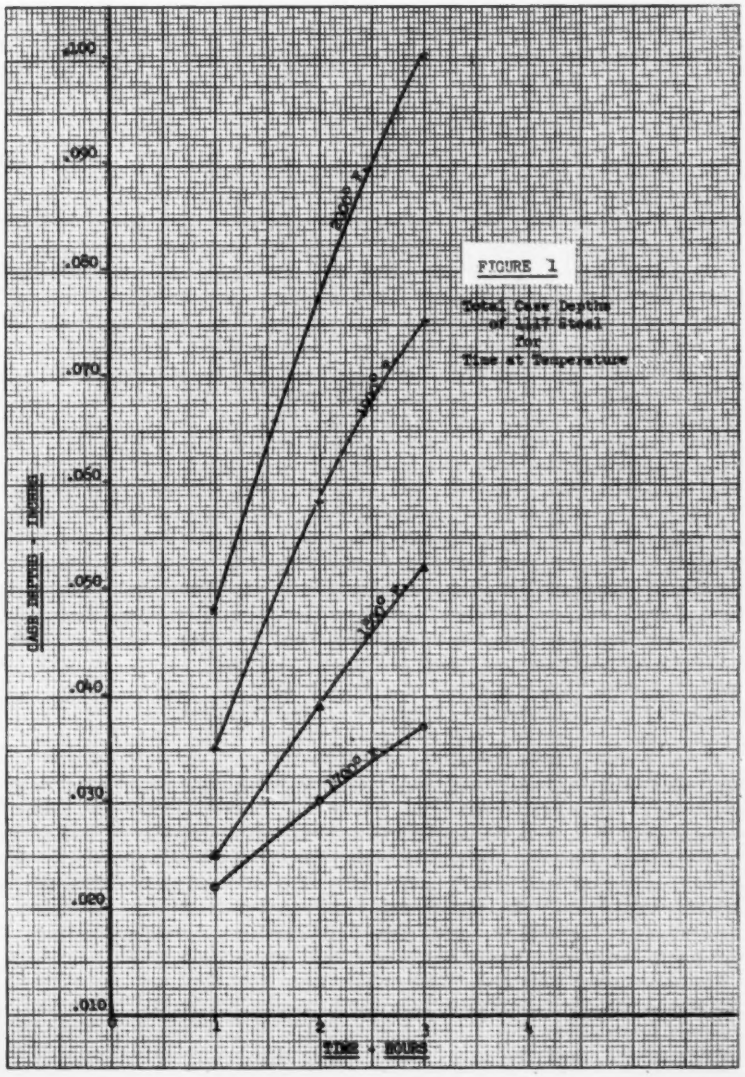


FIGURE 1
Total Case Depths of 1117 Steel for Time at Temperature

Consideration of the first factor reveals that steel suppliers believe many of our present carburizing grade steels are, within certain limitations, suitable for treatments at higher-than-normal temperatures.

In the light of present available information, general acceptance of gas carburizing at abnormally high temperatures is unlikely. Dimensional limit and physical requirements of the part thus carburized may be too critical. However, based on investigation and evaluation of each individual part, it is probable that many will be found adaptable to this new technique. The savings in production cost and time for such parts will certainly warrant the required preliminary investigation.

With a long record of significant developments in high temperature carburizing and carbonitriding furnaces, Ipsen Industries, Inc., of Rockford, Illinois, has for some time built small furnaces suitable for gas carburizing at temperatures up to 2000° F. The adaptation of the same materials and non-metallic parts to furnaces of larger size and productive capacity was a natural step, and consequently, their present furnaces are suitable to gas carburizing at elevated temperatures without major change.

The major contribution to this furnace construction has been the replacement of failure-prone, metal alloy furnace parts with similar parts of high density refractory materials. Such parts are currently used in such critical components as hearth and hearth support members, radiant heat transfer tubes, conveyor rollers for both roller-rail and roller hearth applications, directional flow baffles, and even high speed forced circulation fan equipment. Such parts have been evaluated over the past several years in actual field operation under various types of atmospheres and applications at operating temperatures from 1400° F to well in excess of 2000° F. The incident of a new carburizing concept at higher temperatures is, therefore, substantially pre-solved insofar as furnace materials are concerned.

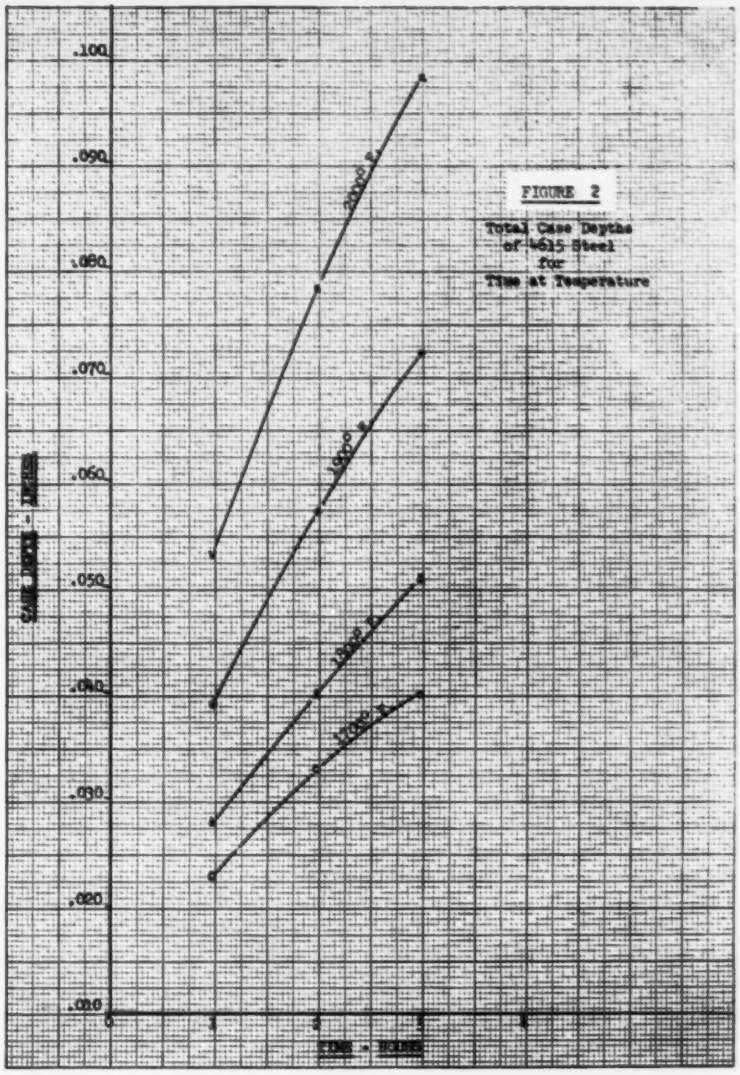


FIGURE 2
Total Case Depths of 4615 Steel for Time at Temperature

After considerable study of the available reports from Europe, a preliminary investigation was planned and conducted to determine the feasibility of the elevated temperatures carburizing process and to investigate the effects of temperature and carbonaceous atmosphere on the furnace involved.

Based on existing design, 2000° F was selected as a maximum furnace temperature for the initial investigation, with duplicating tests performed at 1700°, 1800°, and 1900° F for comparison. Holding times at each temperature were set at one hour, two hours, and three hours, followed by atmosphere cooling. The possible quench reactions following reheating were studied in subsequent investigations. The tests were conducted with four commercial grades of steel, with characteristics shown in Table I.

Tests on the above steels were carried out in a standard gas-fired Ipsen Model TC-100-G furnace, capable of operation at temperatures up to 2000° F, with enriched endothermic atmosphere used in both heating and cooling chambers. Complete forced convection heating of parts was carried out by means of a newly developed ceramic fan. Standard controlled dewpoint type endothermic generator equipment provided suitable atmosphere.

Test bars of the four steels inves-

tigated were cut into lengths of 3" to 3½", rough ground to 0.475" (± .003") to remove possible surface decarburization. The diameter and length of each part was then recorded and the part stamped for identification.

The selected furnace was loaded with the four grades of test bar, interspersed among properly identified new bars of C1018 steel, ⅜" to ⅞" in diameter by 3" to 6½" in length. Twelve such loads were prepared in standard baskets to approximate an individual gross weight of 35 pounds.

Atmosphere from the generator resulted in typical analyses approximating:

CO_2 - O %	H_2 - 41.2 %
O_2 - O %	CH_4 - .5 %
CO - 20 %	N_2 - 38.3 %

Automatic air gas ratio control at the generator provided dewpoints of 350° F for 1700° F furnace operation; 25° F for 1800°; 20° F for 1900°; and 15° F for 2000°. Additive raw natural gas to achieve the lower dewpoints required for the elevated temperatures of furnace operation was thus held to a minimum and controlled through an Ipsen Dewtronik. Atmosphere usage amounted to 200 CFH, and the raw gas additive varied from 5 to approximately 15 CFH. Dewpoints and recovery times were itemized as seen in Table II.

(Dewpoints were checked by Dewtronik, Alnor and Visual CO_2 Cup test and interpolated from published curves to conform to a potential of 0.90% to 1.00% carbon at the four temperatures investigated.)

After treatment, individual parts were remeasured to check dimensional growth and micro specimens prepared for the determination of average total case depth, based on different locations on each sample. "Total Case" was considered to be that depth at which case carbon and core carbon coincided.

The samples treated for two hours were further subjected to successive surface cuts of 0.010", the chips were analyzed for carbon content, and results plotted in Fig. 5.

Table I

AISI NO.	*TYPE*	*C*	*Mn*	*P*	*S*	*Si*	*Ni*	*Cr.*	*Mo*
1117	Carbon	.20	1.23	.031	.113	...	...	...	...
4615	Nickel Moly	.16	.56	.034	.030	.24	1.77	...	.22
8620	Ni-Chro-Moly	.21	.78	.028	.034	.32	.64	.58	.18
9315	Ni-Chro-Moly	.16	.55	.021	.018	.27	3.37	1.25	.11

Table II

	1700°F	1800°F	1900°F	2000°F
Recovery Time	10 mins.	14 mins.	20 mins.	31 mins.
Dewpoint in Furnace	15°-17°	9°-14°	7°-12°	5°-10°
Cooling Time	2 hours	2 hours	2 hours	2 hours

The investigation of dimensional growth resulting from higher temperatures indicated relatively no change nor trend relative to type of material or temperature of processing. Other data, including case depth vs. time at temperature are reproduced on graphical Figs. 1, 2, 3 and 4.

Grain growth was determined in accordance with ASTM E-19 as shown in Table III.

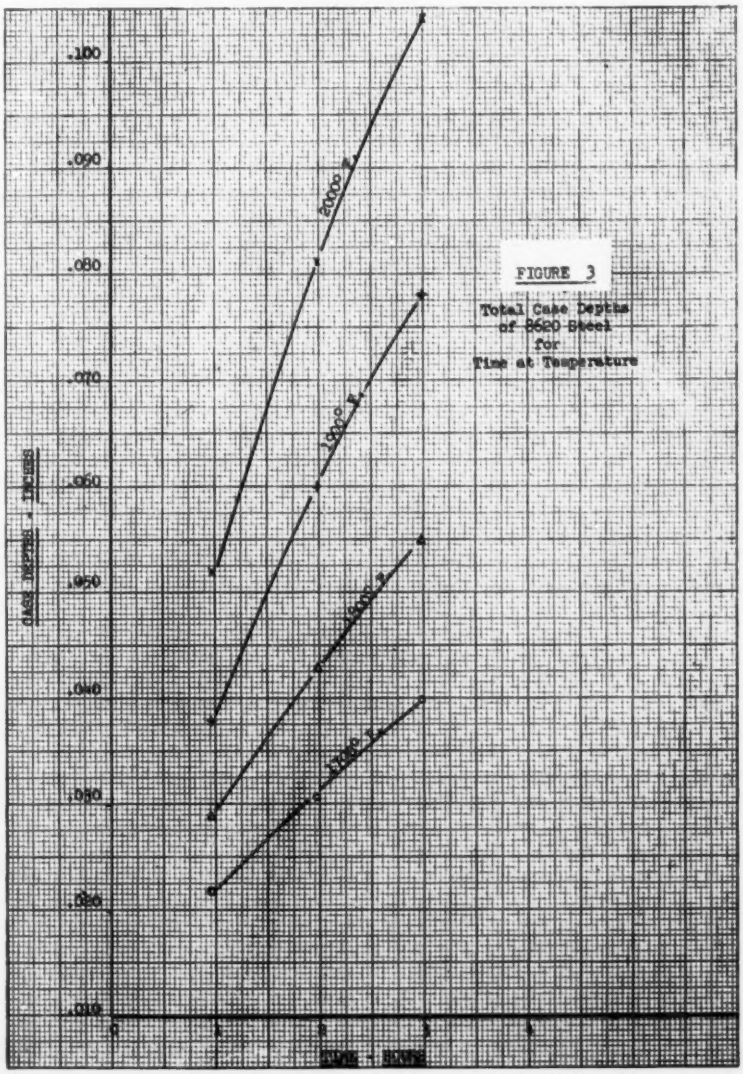


FIGURE 3
Total Case Depths of 8620 Steel for Time at Temperature

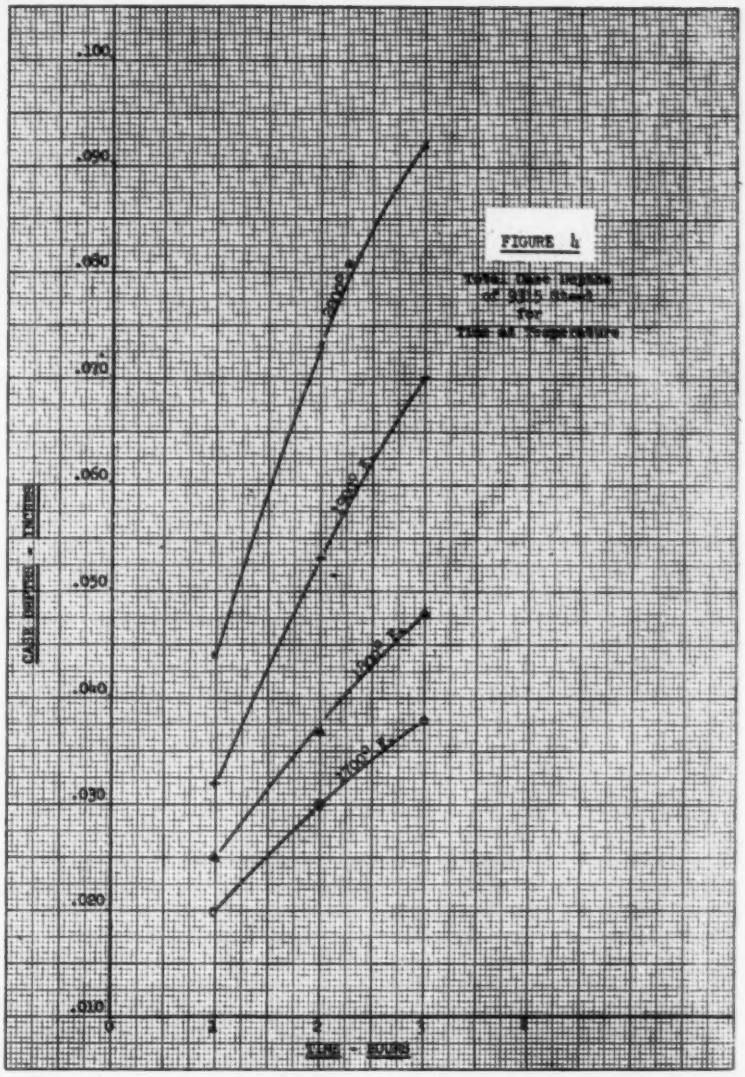
Figure 6 is AISI 8620 steel prior to carburizing, and figure 7 is AISI 8620 core after carburizing for three hours at 2000° F showing the extreme growth of grain from ASTM No. 8 to ASTM No. 3-6 Duplex.

Photomicrographs of the case of 1117 steel subjected to the four carburizing temperatures are shown in figures 8, 9, 10, and 11. These are typical of the other cases.

Photomicrographs of the cases of the four different steels (AISI 1117, 4615, 8620, and 9315) subjected to 1900° F for three-hour cycles are shown in figures 12, 13, 14 and 15. These again are typical of other temperatures.

The one- and three-hour cycle samples were reheated in an Ipsen T-4-600B-GM furnace and held at 1500° F for one hour in a controlled furnace atmosphere having 30° F dewpoint. Samples were then quenched in 150° F Ipsen Double Duty Oil.

The parts were examined microscopically to determine degree of refinement of the grain size of the cases and cores. Figure 16, as compared with figure 7, shows the results of refinement of the very coarse 8620 that had been carburized at 2000° F. The AISI 1117 produced a similar refinement. The AISI 9315 and AISI 4615 steels produced no appreciable change.

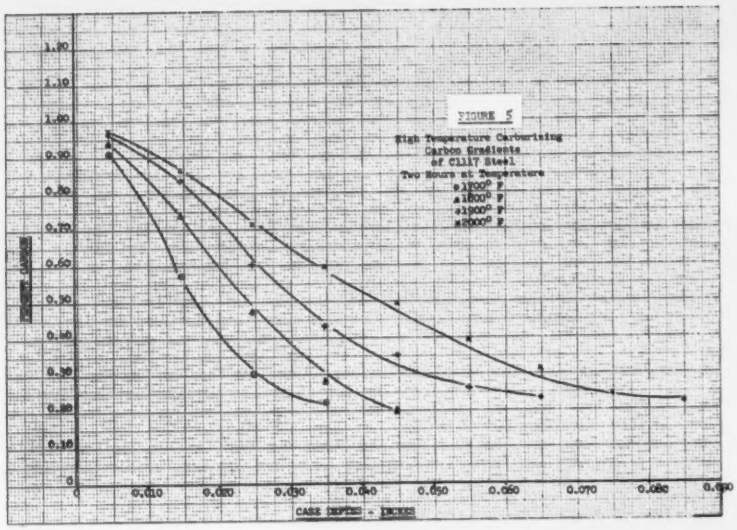


Summary

Conclusions drawn from this preliminary investigation would indicate that upon the steels tested, elevated temperature carburizing with retention of satisfactory grain

Table III

AISI NO.	*PRIOR*	1700° F	1800° F	1900° F	2000° F
(One Hour Cycle)					
1117	8	6-7	6-7	4-6 Duplex	3-5 Duplex
4615	8	8	8	8	7-8
8620	8	7	7	4-7 Duplex	4-6 Duplex
9315	8	8	8	8	8
(Three Hour Cycle)					
1117		5-7	4-7 Duplex	4-7 Duplex	3-6 Duplex
4615		8	8	8	6-7
8620		7	7	3-7	3-6 Duplex
9315		8	8	8	8



structure is practical, especially where a reheat hardening operation is employed.

Comparison of cost of operation and initial investment in process equipment for conventional 1750° F *vs.* 2000° F carburizing indicates that more rapid heating and penetration at the higher temperature can substantially reduce the size of furnace equipment required for a given hourly production, all other circumstances being equal.

Control of atmosphere potential becomes more critical at elevated temperatures and indicates the need for automatic dewpoint control at furnace as well as generator.

Control of temperature uniformity also becomes more critical in the elevated temperature ranges, since accelerated carbon penetration exaggerates discrepancies of temperature differences in the equipment. • • •

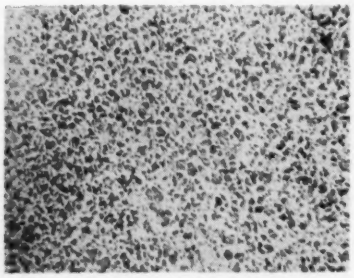


Fig. 6—Microstructure of 8620 Steel prior to High Temperature Carburizing Heat Treatments. Mag. 100 X - 2% Nital Etch.

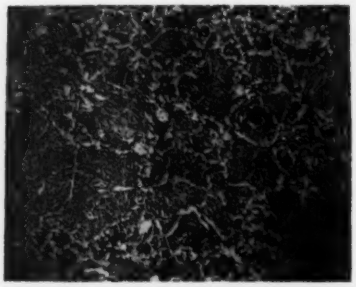


Fig. 7—Microstructure of the Core of ½" Diameter 8620 Steel after carburizing for 3 hours at 2000° F and atmosphere cooled. Mag. 100 X - 2% Nital Etch.

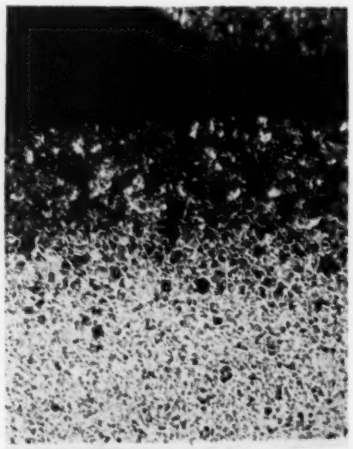


Fig. 8—Microstructure of 1117 Steel after carburizing for 2 hours at 1700° F and atmosphere cooled. Mag. 75 X - 2% Nital Etch.

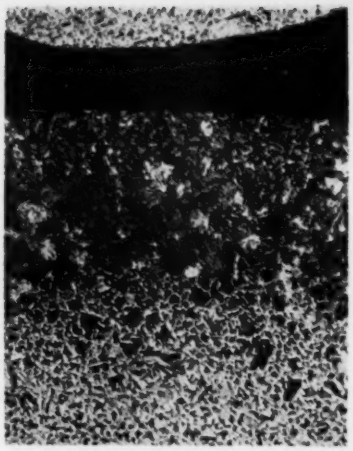


Fig. 9—Microstructure of 1117 Steel after carburizing for 2 hours at 1800° F and atmosphere cooled. Mag. 75 X - 2% Nital Etch.

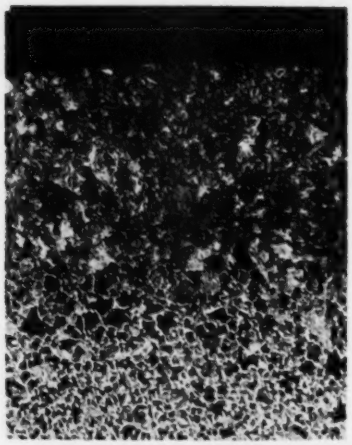


Fig. 10—Microstructure of 1117 Steel after carburizing for 2 hours at 1900° F and atmosphere cooled. Mag. 75 X - 2% Nital Etch.

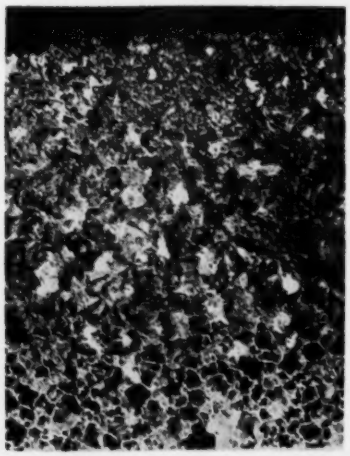


Fig. 11—Microstructure of 1117 Steel after carburizing for 2 hours at 2000° F and atmosphere cooled. Mag. 75 X - 2% Nital Etch.

(Continued on page 42)

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- ☐ Tempering
- ☐ Vacuum Heat Treating
- ☐ Bright Heat Treating
- ☐ Stainless Steel Heat Treating
- ☐ Sintering
- ☐ Copper Brazing and Soldering
- ☐ Lead Pot Hardening and Tempering
- ☐ Atmosphere Equipment
- ☐ Other.....

Name..... Title.....

Company.....

Street.....

City..... State.....

Nickel-Base Alloy For High-Temperature Heat Treating Equipment

By **L. M. Griffore,** Chief Engineer
Misco Fabricators, Inc.,
Marysville, Michigan

In almost all fields of technology, engineers are being pressed to find new materials to cope with ever-increasing temperatures. This is especially true in the field of metal heat treating where materials are needed to improve the performance of furnaces and fixtures at temperatures up to and above 2000° F. At these elevated temperatures, alloys that once were considered too costly for widespread use are now coming into play because of their superior properties. In general, the alloys used at these temperatures contain large amounts of nickel with chromium and other alloy materials. The nickel imparts high-temperature strength and ductility, and chromium increases oxidation resistance.

To compound the temperature problem, the alloys used in furnace applications must also be resistant to a wide variety of furnace atmospheres. They must be capable of resisting oxidation and the effects of carbon and other products of combustion found in some furnace atmospheres. They must also handle artificial atmospheres, such as dissociated ammonia, hydrogen, and various fuel gases.

HASTELLOY alloy X, produced by Haynes Stellite Company, Division of Union Carbide Corporation, is an alloy which has been successful in a variety of furnace applications. Alloy X contains about 45 per cent nickel, 21 per cent chromium, 9 per cent molybdenum, and other alloying additions. This highly alloyed material, in addition to its unusual properties in furnace applications, also possesses good forming and welding charactertistics.

High Strength and Oxidation Resistance

In many of the present applications of this alloy, other materials were tried and failed. Some of the reasons for the success of this alloy at these extreme temperatures can be illustrated by the oxidation curves in Chart I and curves of ultimate tensile strength in Chart II.* It will be noted that in the intermittent oxidation tests in dry air at 2000° F, the alloy X initially gained weight and this weight gain was retained even up to 100 hours. This indicates the formation of a highly adherent oxide scale which does not spall either at high temperatures or on cooling and reheating. This, of course, helps the metal sections retain strength at these temperatures, since the metal loss as a result of oxidation is minimized.

In the plot of ultimate tensile strength against temperature, it can be seen that alloy X has a higher tensile strength than several other alloys commonly used in furnace applications. This higher tensile strength combined with good creep resistance becomes very important at temperatures over 1800° F.

Fig. 1—Excellent ductility of Alloy X is illustrated in this press-brake operation.

To illustrate a few of the jobs that this alloy has successfully handled there follow some actual case histories.

Long Life in Severe Service

A manufacturer of diamond rock-drill bits asked for trays to support the bits during the diamond bonding operation. Bonding is carried out at 2300° F, and the trays had to be capable of supporting 40- to 75-pound

(Continued on page 12)

(See these Charts on page 40)

AT THE HOMESTEAD WORKS OF U. S. STEEL National Alloy Rollers carry USS "T-1" plate up to 45 feet long, 13 feet wide, and 2 inches thick through heat treating furnace.

AT LUKENS STEEL National Alloy Rollers have been in service more than 2½ years where plate up to 172 inches wide and 3 inches thick is heat treated.

National Alloy Rollers provide long service on Drever continuous plate Heat Treating Lines

Establishing better properties in steel plate through heat treating has become a continuous, high output operation at leading steel producers. As the leading specialist in high temperature, high alloy castings, National Alloy, cooperating with Drever, engineered, centrifugally cast and produced some of the largest high alloy rollers now in use to handle plate up to 3 inches thick and 172 inches wide. These rollers vary in diameter from 8 to 14 inches and are 20 feet long.

Meeting the ever-increasing demands of industry for high temperature, high volume equipment has given National Alloy unmatched experience in the development and manufacture of high alloy castings for maximum service. Consult National Alloy for a practical answer to your high temperature and high corrosion problems.

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National Alloy Division, Pittsburgh 38, Pennsylvania

(Continued from page 10)

loads without sagging or warping. The trays were made in the form of grids from 1 in. x ⅜ in. bar. At last report the grids had been used over 100 times and there was no evidence of any serious warpage or attack from oxidation.

failures were traced to two causes. In some cases the copper brazing material was causing corrosion of an intergranular type at the high temperatures. Failure due to thermal shock was also a major factor. Alloy X trays were fabricated and put into service. At the present time tray life has been extended 4 times. There is every reason to believe that tray life will be extended to 8 or 12 times the original figure.

Table I
WELDING DATA FOR ALLOY X

Weld Method	Plate Thickness, in.	Rod Diameter, in.	Currents, Amperes	Argon Flow, cfh	Travel Speed, in./min.
Metal-Arc	⅛	⅛	80	..	..
	¼	⅛	90	..	..
	⅜	⅛	90	..	..
Inert-Gas-Shielded Arc	⅛	⅛	90	35	..
	¼	⅛	105	35	..
	⅜	⅛	105	35	..
Submerged-Melt	¼	⅛	275	..	18
	⅜	⅛	300	..	16
Shielded-Inert-Gas-Metal-Arc	⅛	1/16	275	30	20
	¼	1/16	300	35	16
	⅜	1/16	300	35	16

In another case, a manufacturer was confronted with a series of rapid failures of hearth rollers in a gas-fired heating furnace operating at 2150° F. The rollers were subjected to both mechanical and thermal shock as they came in contact with sheet metal being heated. Alloy X rollers were roll-formed from 3/16 in. sheet into tubes 6½ ft. long and 7 in. in diameter. These shells were then slipped over 2¼ in. water-cooling pipes. Refractory materials were packed into the space between the tube and the pipe and the rollers were installed. To date the rollers have been in operation for more than 6000 hours and are reported to be in excellent condition.

Radiant heating tubes in a continuous annealing furnace operating at 2000° F offer one of the toughest service conditions. The tubes are used as enclosed-flame burners and must resist sagging and oxidation which could be caused by the high-temperature flame. As the furnace is over 400 feet long, tube replacement and downtime for repairs could present a serious problem. Tubes fabricated of alloy X were inspected after a year of steady service. The tubes were found to be in excellent condition, were reinstalled, and are still operating satisfactorily after more than 34 months of use.

One of the large automotive manufacturers ran into a problem in copper brazing transmission parts. High-alloy trays, loaded with parts to be brazed, were furnace-heated to 2150° F. Tray life was alarmingly short and replacement costs were getting out of hand. Tray

Alloy Readily Welded and Fabricated

In general, the alloy is handled in the shop in much the same manner as stainless steel. Since this material is stronger and tougher, power requirements may be slightly higher. This is of no consequence, however, unless you are operating at or near the capacity of the machine. In press-brake bending operations performed

(Continued on page 14)

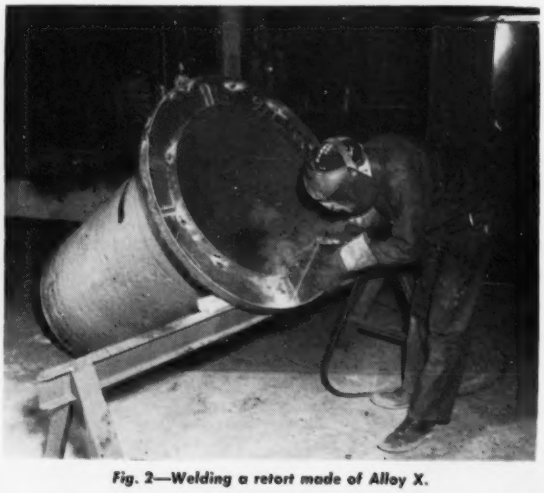

Fig. 2—Welding a retort made of Alloy X.

"Excellent Results Have Proved the Value and Versatility of Park's Non-Burning Carburizing Compounds"

Says L. A. Lindberg

President, Lindberg Steel Treating Co.
Chicago — Rochester — St. Louis
Los Angeles

"We have had excellent results with this Non-Burning Carburizing Compound for many years. For example, the pinion gear shaft that Milt Vandenberg is looking over has a heat treat specification of .040-.050" case depth and Rockwell 59-62 "C" Scale hardness.

"We process production quantities of these shafts in a two row, automatically controlled, pusher-type furnace using Park's Non-Burning (grade W) Carburizing Compound. The compound supports the parts during carburizing so that distortion is controlled and straightening operations are minimized. Tooth form and lead angle of the gear remain within the allowable tolerance and case depth is very accurately controlled.

"The value and versatility of this operation for such parts as well as for low-cost production items has been proved to us over the years. We have learned to depend on Park for uniformity and for service!"

Park NON-BURNING CARBURIZING COMPOUND is available in sizes No. 3, 6, and 8, and in two grades: "B" and "W". The latter grade is designed to minimize the possibility of copper migration on copper plated work. All sizes and grades are manufactured by coking a special quality coal in the presence of the energizing chemicals. This process produces a homogeneous compound and insures uniform carburizing activity even though usage reduces the material to pinhead size. Shrinkage rates are low and carburizing activity can be maintained indefinitely with addition ratios of as low as 1 to 10.

NON-BURNING is the quality carburizing compound that is economical to use. In addition to its uniformity and low replenishment requirement, it does not burn after removal from the furnace. NON-BURNING is especially suitable for carburizing alloy steel parts such as gears which are direct quenched or reheated. Send for the free, informative technical bulletin B-1, "Pack Carburizing of Steel in Solid Compounds".

● ● ●

Woodside Rapid Carburizers (Non-Burning—Charcoal-Coke-Specification) ● Park-Kase Liquid Carburizers ● Quenching and Tempering Oils ● Cyanide Mixtures ● Neutral Salt Baths ● High Speed Steel Hardening Salts ● Iso-Thermal Quenching and Tempering Salts ● Protective Coatings (No-Carb—No-Kase—No-Scale—No-Tride) ● Carbon Products (Charcoal-Crushed Coke-Pitch Coke-Lead Pot Carbon) ● Kold Grip Polishing Wheel Cement ● Par-Kem Metal Cleaners ● Cutting and Grinding Compounds (Kem-Cut—Kem-Grind—Blue Ice)

Park **PARK CHEMICAL COMPANY** ● **8074 Military Ave. Detroit 4, Mich.**

(Continued from page 12)

on the alloy, it pays to use liberal bend radii of the order of 3 times the material thickness. The alloy work-hardens quite rapidly, and too small a bend radius may cause cracking in the bend area.

Metal-arc welding is commonly used in building up fabricated sections of this alloy. Coated rod is available for this purpose. Direct current with reversed polarity is normally used since it produces the best mechanical properties in the weld. Where joint design permits, rapid travel with as little "weaving" as possible is preferred in order to minimize heat input. Minimum currents, consistent with the thickness of the material, should be used so that overheating can be minimized. Because of the fluidity of the alloy, position welding may be somewhat difficult. Whenever possible, welding should be done in the downhand position.

Inert-gas-shielded-arc welding may also be used. In general, heat input should be minimized and the weld deposit should be cooled as rapidly as possible following welding. Some welding details for the various welding processes are listed in Table I.

In general, standard weld joints can be used for HASTELLOY alloy X. Particular attention, however, should be given to weld penetration. To insure uniform penetration, slightly larger gap widths might have to be used than would be used for steel. Non-uniform penetration in material used for high-temperature applications can create stress-raisers which may serve as focal points for mechanical failure.

Alloy X is machinable in both the wrought and cast forms. Low cutting speeds and an ample flow of a sulphur-base cutting fluid are required. The machining guide lists some typical speeds and feeds for use with various types of tools. These values will be modified by such factors as tool size and type, type of machining equipment, size of stock, and nature of cut. • • •

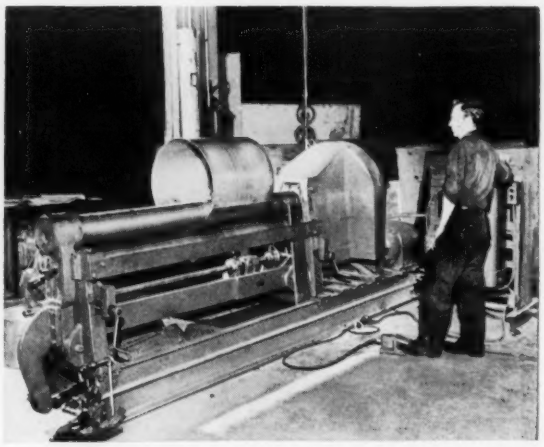

Fig. 3—Slip-roll forming a cylinder made of Alloy X.

Table II

Machining Guide for Alloy X

Operation	Tool	Speed, SFPM	Feed. In. Per Rev.		Depth of Cut, In.	
			Rough	Finish	Rough	Finish
Turning	Tungsten Carbide	68-88	.009-.016	.006-.009	.050-.100	.011-.015
	High Speed Steel	18-21	.007-.011	.003-.008	.025-.045	.008-.011
Facing	Tungsten Carbide	68-88	.009-.016	.005-.009	.040-.075	.011-.015
	High Speed Steel	18-21	.007-.011	.003-.008	.025-.045	.008-.011
Boring	Tungsten Carbide	42-53	.003-.007	.005-.009	.043-.060	.012-.015
Drilling	High Speed Steel	14-21	.005-.010 .009-.016	.002-.004	—	—
Reaming	High Speed Steel	7-13	—	—	—	.012-.015
Shaping	Tungsten Carbide	20-30	—	.005-.010	.060-.090	.018-.025
	High Speed Steel	13-15	—	.005-.010	.050-.080	.018-.025
Milling	High Speed Steel	15-25	½-1 In. Table Feed/Min.		.100-.200 In. Cut	

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NEW FURNACE FOR MISSILES

By **THOMAS A. DICKINSON**
West Coast Reporter

A ONE-THIRD MILLION dollar Gantry heat treating system, large enough to cover almost half of a city block and perhaps the biggest thing of its type in the world, is scheduled to be in operation at Douglas Aircraft Company's Torrance (Calif.) plant by the end of 1958.

Its major components—including a Gantry furnace, a draw furnace, and two quench tanks—are currently under construction at Pacific Scientific Co., Bell Gardens, Calif. It will be used to heat treat power plant components for Douglas' Thor missiles.

Main element of the facility, for which a 7500-sq. ft. floor area has been reserved, will be the Gantry quench furnace with a 74" i. d. vestibule and 18" high heating compartment. It will be mounted on floor-level rails so that it can be automatically moved fore and aft to positions directly above the draw furnace, the quench tanks, and a loading bay (where it will use an integral elevator mechanism to pick up parts).

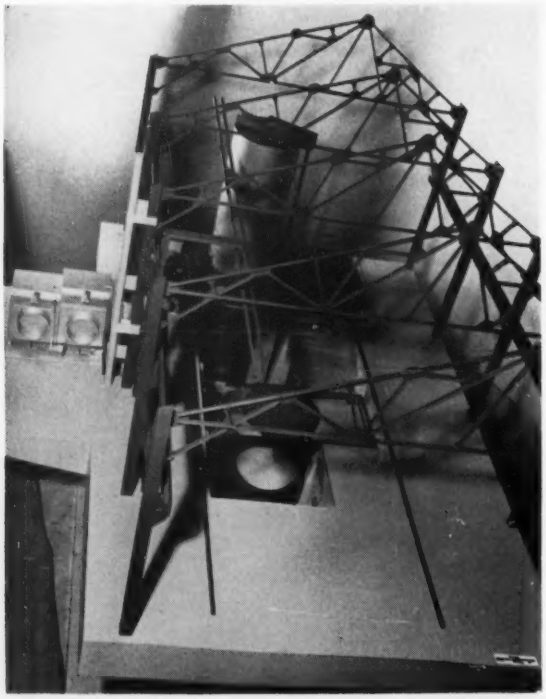


Fig. 1—General view of scale model of Gantry heat treating system now being built by Pacific Scientific. Building framework, which is part of model, indicates the nature of problems associated with installation of the system in Douglas Aircraft plant.

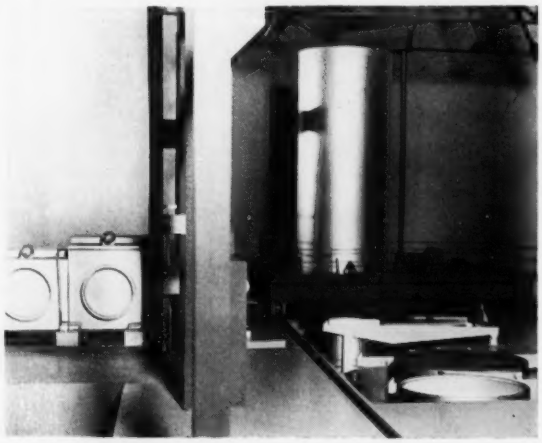


Fig. 2—Closeup view of scale model. Two endothermic generators can be seen at left. In right background is rail-mounted Gantry furnace. In lower right foreground, partly-covered draw furnace and one of two quench tanks can be seen.

Rated at 400 kw., the Gantry quench furnace will have four zones of control (each 100 kw.) and has been designed to maintain close-tolerance temperatures up to 2000° F.

Two sub-surface quench tanks have been specified for the heating system, because different missile components will require oil and atmospheric quenching media.

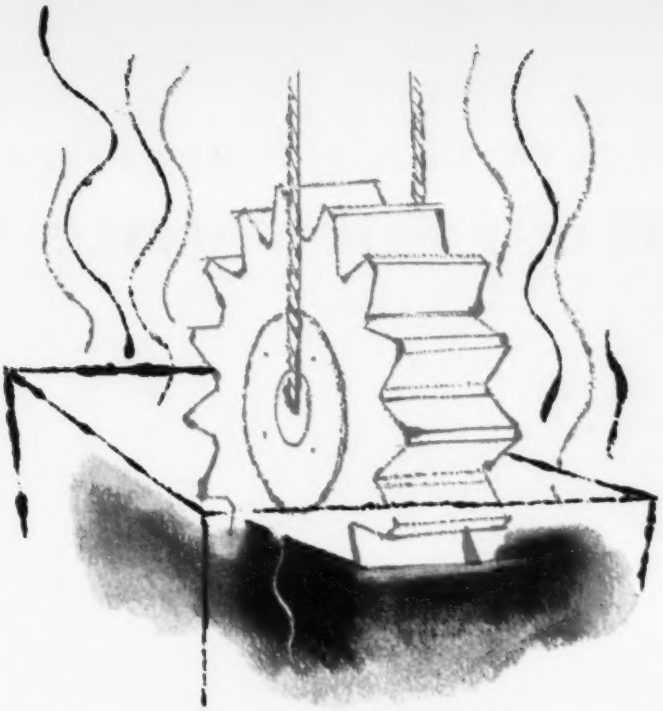
Pneumatically operated sleeves and atmospheric controls will make it possible to join the latter tanks to the Gantry furnace so that heat treated parts can be immersed in either quenching medium without being exposed to the oxidizing constituents of air.

The system's pit-type draw furnace will have a 74" i. d., 216" deep work area; a rating of 200 kw., and ability to maintain close-tolerance temperatures up to 1250° F. It will use a pair of 25 hp. blower assemblies to pass gases in a helical path up across its heating elements then down through the work chamber and back to the blowers.

Vertical, cylindrical designs of both furnace and quenching facilities are expected to permit the jigging of parts so that minimum warpage will occur when temperatures are suddenly reduced.

Two endothermic generators—one rated at 8000 and the other at 5000 CFM—will provide inert gases for

(Continued on page 34)



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QUALITY INSTRUMENTS PERMIT BETTER-THAN-STANDARD TEST PERFORMANCE

By **WILLIAM F. CAREW,** Chief Engineer
Barber-Colman Company
Wheelco Instruments Division
Rockford, Illinois

OUTSTANDING PERFORMANCE on creep and stress-rupture tests is being achieved regularly with the testing facilities available at the Joliet Metallurgical Laboratories, Inc., Joliet, Illinois. A major contribution to this performance record results from the proper application of modern instrumentation in terms of temperature control. To achieve outstanding temperature regulation, well within the ASTM specifications, the laboratory has standardized on Wheelco 407 Saturable Reactor Capacitrols. It has been possible to control in some instances to within plus or minus 1° F in making these tests.

Fig. 1—Chief Engineer, William F. Carew, points to recorder chart, demonstrates control accuracy being achieved at Joliet Metallurgical Laboratories.

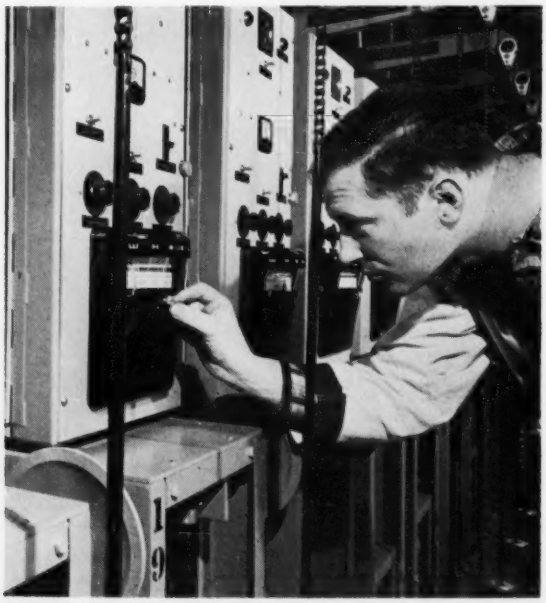

Fig. 2—Hairline adjustments used on creep-test furnaces are made readily.

Although accuracy and reproducibility are the governing factors behind the purchase of instruments for a test installation such as this one, low initial cost and an impressive maintenance record are considered to be equally significant. The Joliet Metallurgical Laboratory standardized on this battery of instruments after it was

Fig. 3—Part of battery of creep-test furnaces.

Fig. 4—Ease of replacement of plug-in chassis is demonstrated in this close-up.

determined that quality of performance measured up to or exceeded other available instruments.

In the Joliet application the instruments are used in conjunction with resistance wound furnaces. Materials being tested range from alloys of magnesium, aluminum, and titanium, through the stainless steels, to the super alloys, and cover a temperature span from approximately 400° to 2200° F. In creep and stress-rupture testing two factors are essential: accuracy of load application and quality of temperature control.

These instruments have proved their value in quick and easy maintenance. Famous plug-in chassis design saves much testing time that otherwise might be lost. Without these features a serious crimp in operations would result through suspension of tests while repairs are being made. With these instruments the entire chassis containing the tube, transformer, and all major

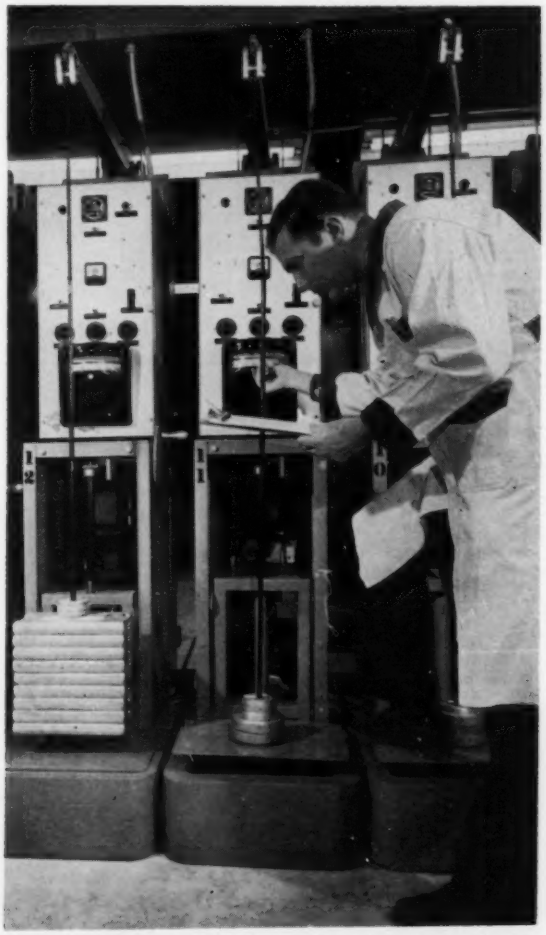

Fig. 5—Readability of large, clear scale on instrument makes recording a simple job.

operating components, is removed at one time. A pre-checked spare can be inserted and the malfunctioning chassis removed to the shop for location of the trouble under ideal conditions, from the standpoint of both time and test equipment. • • •

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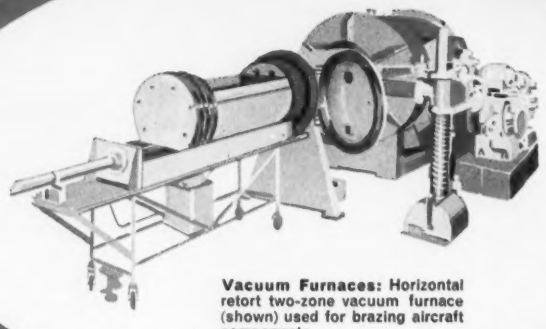
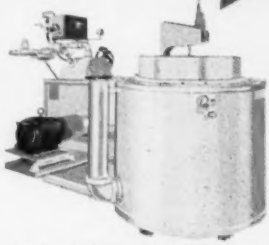
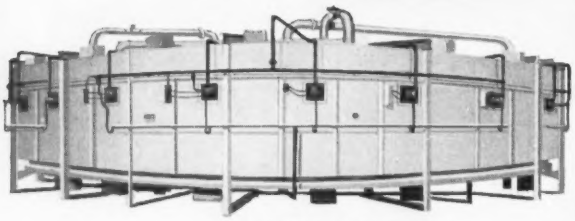


Vacuum Furnaces: Horizontal retort two-zone vacuum furnace (shown) used for brazing aircraft components.



Cyclone Tempering Furnaces: Batch type fuel-fired tempering furnace (shown). Famous in metal treating industry for years.

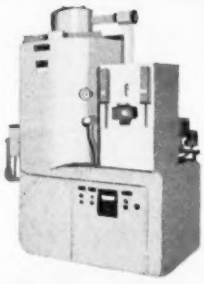


Rotary Hearth Furnaces: Doughnut type field-installed gas-fired furnace (shown) with capacity of 13,000 lbs. per hour.

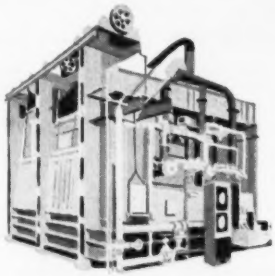
Ceramic Kilns: Completely automated atmosphere controlled kiln with 8 zones of temperature control (shown). Maximum temperature, 2700°F.

Pilot Plant Equipment: Atmosphere tube unit (shown) for ceramic research and development at temperatures up to 2750° F.

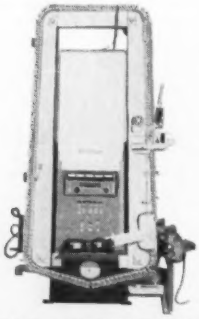
Laboratory Equipment: One-unit box furnace (shown), muffle or for non-oxidizing atmosphere with temperature range to 3000° F.



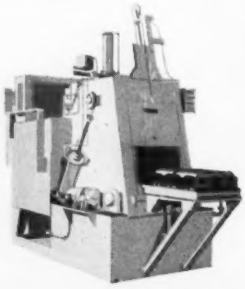
Atmosphere Generators: Hyen generator (shown) for endothermic atmospheres. Generators for all required atmospheres.



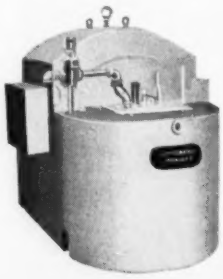
Aluminum Reverberatory Furnaces: Twin-chamber melting and holding furnace (shown) with 45,000 lbs. capacity.



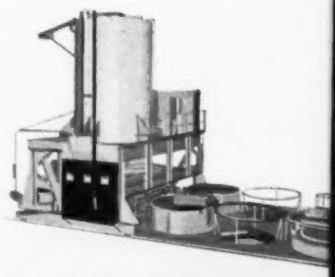
High Frequency Units: Vertically designed, completely automatic "HF" unit (Shown) for aluminizing automotive valves.



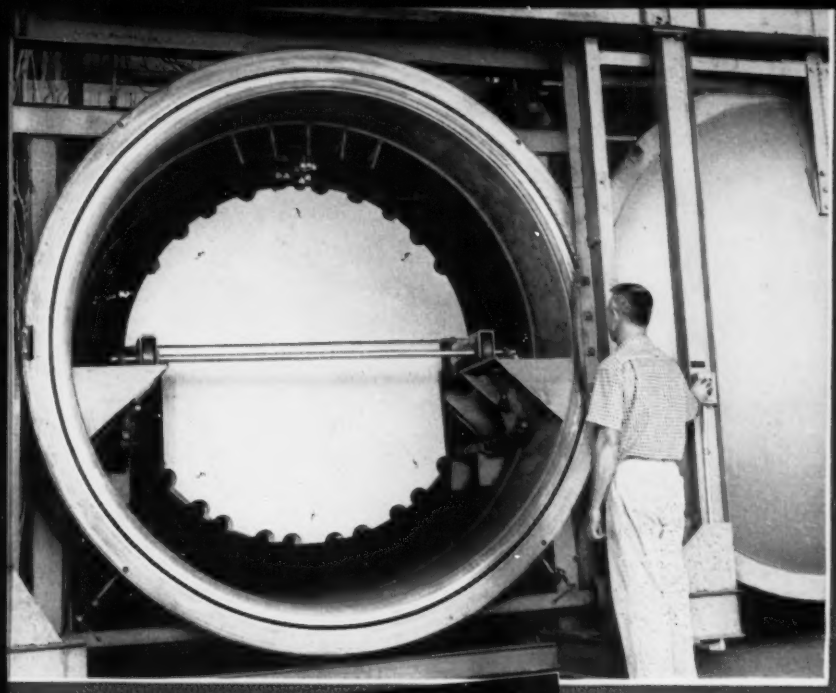
Automatic Carbonitriding Furnaces: Automated integral quench type (shown) with CORRTHERM electric elements.



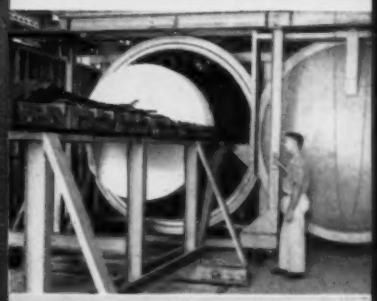
Melting and Holding Furnaces: Electric resistance furnace (shown) with capacities of 750 lbs. to 1500 lbs.



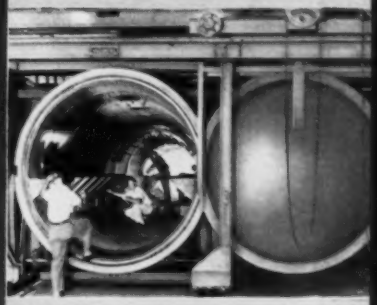
Gantry Type Furnace: Vertical, controlled-atmosphere, drop bottom, hardening furnace. Complete installation field-installed by Lindberg.



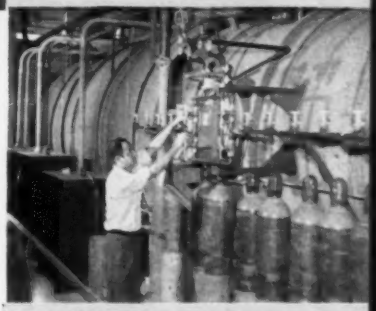
Lindberg-Designed



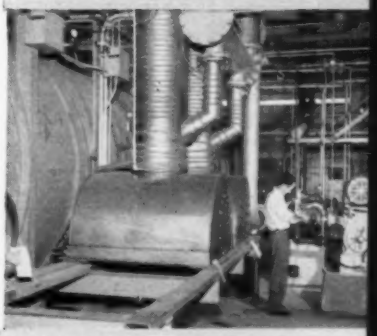
6 feet in diameter, the furnace easily takes large titanium sheets.



Total furnace length is more than 40 feet.



After vacuum cycle, inert gas is introduced into chamber to assist cooling.



Specially designed pump maintains vacuum of less than one-millionth of an atmosphere.

Large Capacity Vacuum Heat Treating Furnace Improves Titanium Quality, Saves Money in Aircraft Manufacture

Here is an outstanding example of Lindberg's ability to apply a basic furnace design to the requirements of a specific job. This vacuum furnace was designed for a leading aircraft manufacturer to heat treat large sheets of titanium. In operation it reduces the hydrogen content of the metal from 500 parts per million to 50 parts per million or less, in a maximum time of 6 hours. And this improvement in quality is achieved with a corresponding reduction in production costs. The furnace has a temperature range up to 2100° F. and operates in a vacuum of less than one millionth of an atmosphere. A unique internal cooling system makes the furnace adaptable for brazing stainless steel honeycombs, a new development in aircraft manufacture.

Lindberg equipment and planning can help you find the answer to any problem of applying heat to industry. We cover the field, heat treating, melting and holding, tempering, brazing, enameling furnaces, ceramic kilns, high frequency units, and are in the ideal position to recommend the equipment most suitable for your needs. This can be factory built or field-installed in your own plant, fuel-fired or electric. Consult your local Lindberg Field Representative (see the classified phone book) or get in touch with us direct. Lindberg Engineering Company. 2466 West Hubbard Street, Chicago 12, Illinois. Los Angeles Plant: 11937 South Regentview Avenue, at Downey, California.

LINDBERG heat for industry

HEAT TREATING HINTS

Editor's Note: *The following correspondence was deemed of such importance to the heat treating industry in general that we are publishing the exchange of correspondence in its entirety in this column of Metal Treating.*

Heat Treating Hazards and Precautions

Mr. C. E. Herington, Editor
Metal Treating

Dear Sir:

I would like to obtain information on the hazards and the precautions that should be taken in heat treating operations.

We are making a safety audit of our electric furnaces, atmospheric furnaces, cyanide, salt, and lead baths.

Any help you can give me will be appreciated.

(Signed) W. R. Cocke
Personnel Practices and Safety Sub-Section
Locomotive and Car Equipment Department
General Electric Company
Erie, Pennsylvania

This inquiry was turned over to Mr. John H. Ries, General Manager of Lakeside Steel Improvement Company in Cleveland, Ohio, and Chairman of the Safety Committee of the Metal Treating Institute. His answer is valuable for the entire heat treating industry, and his letter in its entirety follows:

Dear Mr. Cocke:

Mr. Herington has referred your letter to the M.T.I. Safety Committee, of which I am Chairman. At our last Committee meeting, we reviewed your request and respectfully submit the following suggestions for whatever help they may be.

Naturally, the same general safety precautions that prevail in all manufacturing operations are also of paramount importance in a heat treating department. Good housekeeping, an experienced and active safety committee, etc.; these we obviously exclude and list only those safety precautions and hazards which we feel are peculiar to our industry.

All heat treating equipment that is manufactured for resale today must meet the standards of the National Board of Fire Underwriters. This equipment is thoroughly safety checked and protected with adequate safety devices by the manufacturer prior to sale and installation. Too often, for special and specific applications, changes are made in original equipment by the purchaser without regard to continuing this same degree of safety. This should be avoided, and your Safety Committee should review all alterations and repairs before furnace equipment is put into service.

Briefly, we would classify the hazards that you may expect to encounter in a heat treating operation as follows:

1. Oil Quench Fires
2. Flammable Atmosphere Hazards
3. Fuel Explosions in Gas and Oil-Fired Furnaces
4. Electrical Breakdown Fires
5. Storage Tanks and Piping for Flammable Liquids
6. The usual hazards present when handling such poisons as Cyanide and Lead. Also, the danger of moisture around any molten material.

The greatest single hazard in heat treating operations is, of course, fire. For your purposes, we will confine our remarks to fire prevention. This is particularly true considering the advanced use of specially-prepared atmospheres at high and low temperatures, and the use of various gas ratios at these temperatures.

Further classification of heat treating fires would list oil quench fires as the most prevalent and the most dangerous. Many statistics on the hazards of Oil Quenching Tanks are available. The best data we have seen to date is a Factory Mutual R publication entitled *Oil Quenching of Metals.* We have attached hereto a list of references, and you will note thereon a number of Factory Mutual Booklets, all of which we recommend.

About one year ago, our industry conducted a survey on oil quenching fires. From our own personal experiences, we arrived at the following conclusions:

1. The causes of most oil quenching fires could be classified as:
   a) Partially submerged work
   b) Overheating the main body of the oil
   c) Exposure of the oil to the furnace

Obviously, then, the preventive measures taken to eliminate these hazards will be a protection against over 80 per cent of this type of fire. Second best, of course, is to be well prepared with adequate fire-fighting equipment suitable for fighting these fires quickly and thoroughly. The May-June 1958 issue of *Metal Treating* has a very descriptive outline of a typical Continuous Quenching Tank installation.

Our Committee feels that rather than repeat data gathered from various publications and enumerate this

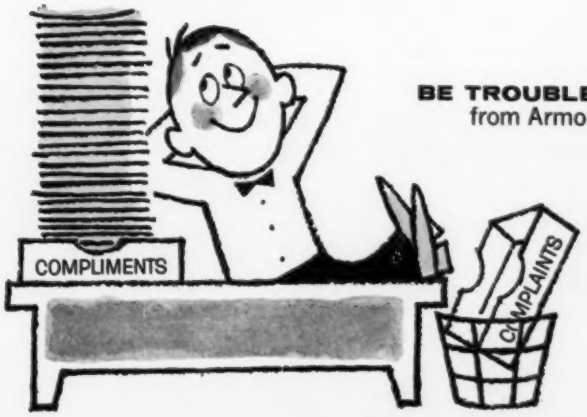
(Continued on page 38)

JANUARY—Bought anhydrous ammonia at bargain price on supplier's vague quality claims . . .

LATER—Moisture in furnace . . . discoloration of finished parts . . . pickling and polishing necessary . . .

STILL LATER—Oil! Pressure regulators clogged . . . dissociator catalyst poisoned . . . incomplete dissociation . . .

TOO LATE—Parts and profits in scrap pile . . . metal treating line down for replacements and repairs . . .



BE TROUBLE-FREE! Buy the trouble-free ammonia from Armour—purest money can buy!

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Quality ammonia from the most distribution points . . . 171 cylinder stock points, 12 bulk stations!

Editor's Note: This is the fourth article on this topic of a series which will be published in the next several issues. They have been abstracted from the book *Injury in Ground Surfaces* by Dr. L. P. Tarasov of the Norton Company Research Laboratories with the kind permission of the publisher, the Norton Company, Worcester, Mass., who also furnished the photographs.

Detection of Surface Stresses

Even though the detection of stresses in ground surfaces is of minor practical importance compared with the detection of cracks and burn, it is well to know something about it. The chances are that more will be heard in the future about the effects of injurious surface stresses upon the useful life of parts in highly-stressed applications, such as occur in aircraft engines.

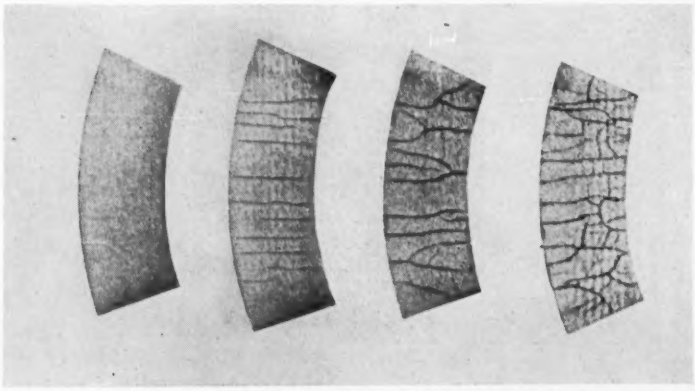


Fig. 1—Typical etch-crack patterns in severely ground hardened steel. The samples of oil-hardening tool steel were surface ground progressively more severely as pictured from left to right, resulting in correspondingly higher surface stresses. Etching the pieces for 15 minutes in cold sulphuric acid caused the stresses to develop into etch cracks except in the piece at the extreme left, where the stresses had been kept low by grinding gently, so that no etch cracks could be formed. The cracks were very narrow and had to be Magnafluxed to make them more clearly visible in the photograph. (Actual size.)

Also, stresses in hardened steel surfaces that have been ground can furnish a convenient index or measure of the severity of grinding and heat treatment. Since such stresses can be detected most conveniently in hardened steel by an etching technique that transforms the stresses into etch cracks, it is easy to misinterpret the results by assuming that the cracks were already in existence prior to etching. It has been known to happen in practice that ground parts have been rejected after etching on account of surface cracking, when they were actually not cracked at all before they were etched but were only highly stressed, a condition not nearly as harmful as cracking.

At this point, it is well to explain why it happens that ground surfaces, if stressed at all, are stressed in tension and not in compression. When a spot in the surface is heated momentarily to a high temperature during contact with the grinding wheel, it wants to expand. The hot spot cannot expand parallel to the ground surface because the surrounding cold metal is too rigid to be deformed by the much weaker hot metal; hence the latter is forced to flow plastically perpendicular to the surface, resulting in a case of hot upsetting on a microscopic scale.

Almost immediately the hot spot cools down and wants to shrink back to its original size, but it can no longer flow because it is cold. Thus there is slightly less metal at the spot in question than there should be, and this means that to fill the space, the metal there must be stressed in tension. Of course, if the tension stress set up in cooling is great enough to exceed the rupture strength of the material, a crack will form in that region. Another way of looking at it is that a crack will form if there is a great enough deficiency of metal in a spot after it has cooled to room temperature.

It should be kept in mind that the dimensional changes involved in the hot upsetting which we have described are of microscopic or submicroscopic size, even smaller than the dimensions of surface roughness, so that they cannot be measured but must be deduced indirectly from other evidence, which need not be discussed here.

When a piece of hardened steel whose surface is highly stressed in tension is etched either in *sulphuric* or *hydrochloric* acid, it is likely that etch cracks will develop in the most highly stressed regions. Etch cracks seem to form only if the steel is sufficiently hard, say Rockwell C55 or higher. No method is known by which similar stresses in other hard metals, such as cemented carbides, can be developed into etch cracks.

The question may arise as to why *nitric* acid, which has been recommended previously for the detection of actual cracks, does not also cause etch cracks to develop out of high tensile stresses in hardened steel. The reason is that nitric acid does not embrittle the steel, whereas sulphuric and hydrochloric acids do embrittle it and thus weaken it, so that regions highly stressed in tension can no longer withstand rupture. The embrittling action of sulphuric and hydrochloric acids is the result of the absorption by the steel of free hydrogen liberated at its surface as it is gradually dissolved by the acid.

With nitric acid there is no free hydrogen available to enter the steel and embrittle it since the hydrogen that is formed at the surface is im-

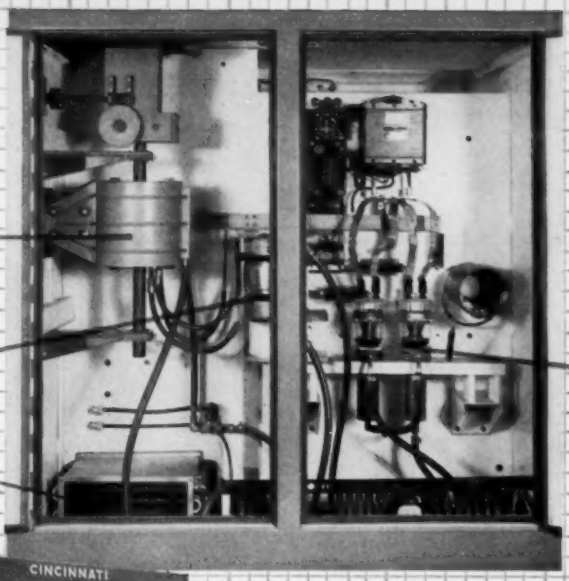
(Continued on page 43)

the oscillator section (shown at right), from the power supply section (shown below). Door interlock switches are used on all access panels. All components are readily accessible and arranged for easy maintenance.

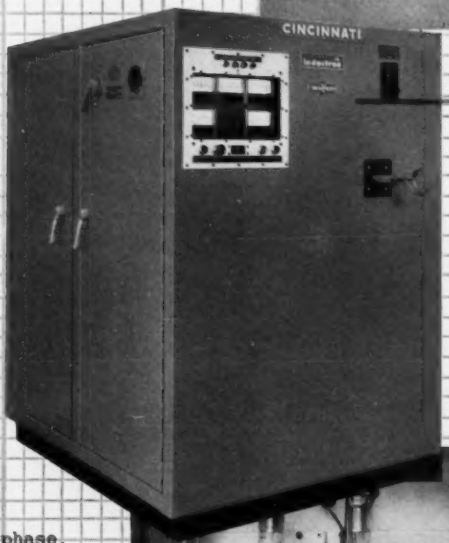
With this variable output RF transformer, output can be varied under load from 30% to 100% rating by positioning one dial.

Simplified, high KVA rated tank circuit includes vacuum capacitors for lowest possible power loss.

Cabinet air is cooled by water heat exchanger and blower. Air and water temperatures are thermostat controlled.



New type, extra-rugged duty low Mu oscillator tubes are especially designed for rugged industrial use. Filament supply to these tubes are both voltage regulated at ± 1% of nominal and ± 3% over a 27% line supply variation, and current limited to 200% inrush. Rectifier filaments also receive the same regulated supply. This insures longest tube life.

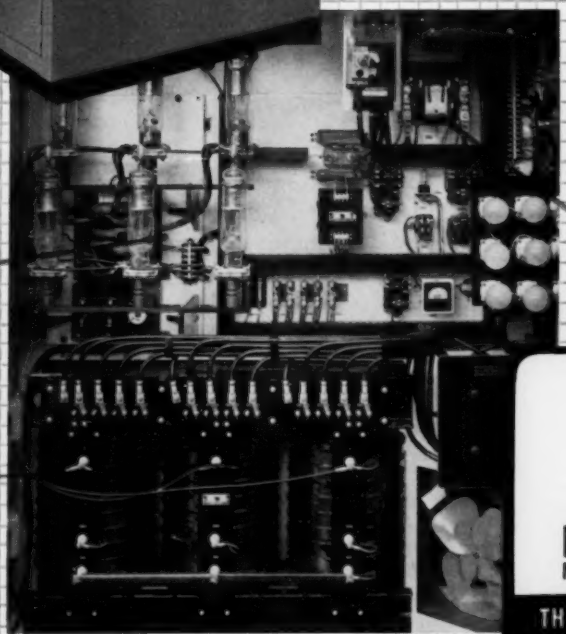


Here is the 30KW Cincinnati Inductron – operates at frequencies of approx. 1200KC. Also built in 15KW and 50KW capacities. A compact, self-contained, one cabinet unit.

Important Note to Users of Induction Heating Equipment

The CINCINNATI INDUCTRON has the design that provides for highest operating efficiency – maximum component life – easiest, lowest-cost maintenance. Check these features–

All controls are panel mounted, providing easy access for inspection and maintenance. Controls provide a more complete cross-section indication of the operation of the circuit than any other induction heater in the field.



Three phase, full wave bridge rectifier circuit uses industrial-type, heavy duty mercury vapor rectifier tubes. Tubes are arranged for even, forced air cooling.

Complete encapsulation against moisture and dirt, plus pie-type secondary windings, and even, forced air cooling, insure long life for the plate supply transformer.

For detailed information, call in a Meta-Dynamics Division field engineer.

inductron
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hardening machines

META-DYNAMICS DIVISION
Machines for Metal Forming and Heat Treating

THE CINCINNATI MILLING MACHINE CO.
Cincinnati 9, Ohio, U.S.A.

CINCINNATI

M.T.I. *Activities*

1959 MTI SPRING MEETING

Definite arrangements and dates have now been made for the forthcoming Annual Spring Meeting of the MTI. This year it will be held at the Hollywood Beach Hotel and Country Club, Hollywood-By-The-Sea, Florida, on Wednesday, Thursday, and Friday, April 22, 23, and 24.

The facilities of this famous resort for the technical and business sessions as well as for pleasure are excellent. A balanced technical program is being arranged for the morning sessions, and each afternoon and evening will be devoted to the use of the outstanding recreational facilities. Members attending the meeting will enjoy complimentary membership in the Golf Club and will play on the Championship 18-Hole Golf Course at no charge. This is a 6322-yard course, and has a men's par of 36-34-70, and a ladies' par of 37-35-72. In addition, guests may make use of an Olympic-size swimming pool and a 1000-ft. private beach on the Atlantic Ocean. Miami Beach is only 10 minutes away from the hotel by car.

No member should miss this meeting; reservation blanks and a detailed program will be sent shortly.

1958 ANNUAL MEETING

The Annual Meeting of the Metal Treating Institute was held at the Hotel Cleveland, Cleveland, Ohio, on October 30, 31, and November 1. This was the 44th consecutive meeting of the Institute.

One of the outstanding features of the 3-day meeting was the participation for the first time by the members of the Institute in a jointly-sponsored Technical Session which was part of the 40th National Metal Exposition and Congress held in Cleveland during the last week of October. The joint MTI-ASM Heat Treating Session was held Thursday, October 30, in the Hotel Cleveland. Mr. Michael Soviak of Commercial Steel Treating Corp., Detroit, Mich., acted as Chairman of the Session, and the following members of the MTI presented papers:

Mr. Fred Heinzelman, Jr.
Fred Heinzelman & Sons, New York City—
"Limiting the Distortion of High Strength Steels With Simple Tempering Fixtures."

T. H. Crane
Kinetics Corporation, Hingham, Massachusetts
"The Heat Treatment of Metals in a Vacuum"

Charles F. Lewis
Cook Heat Treating Co. of Texas, Houston, Texas
"Expected Variation in Hardenability of AISI-4142 Steel"

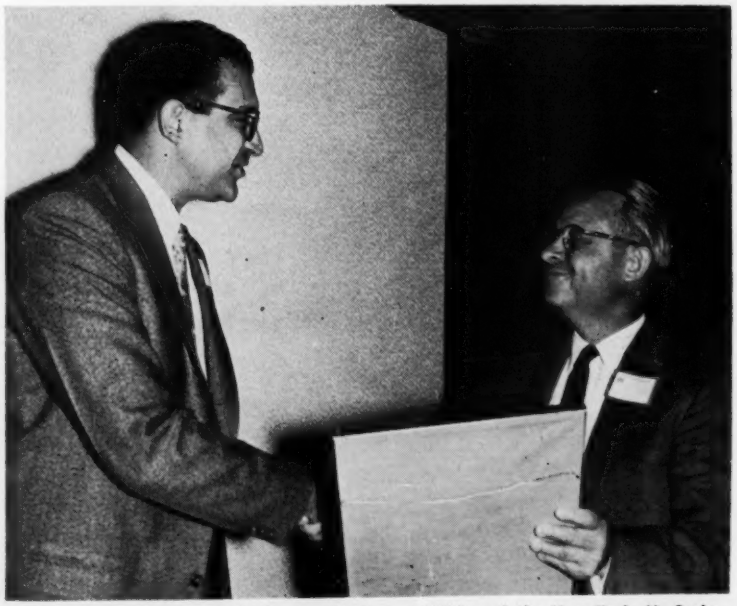
Horace C. Knerr
Metlab Company, Philadelphia, Pa.
"Mysterious Failures in Heat Treating and Their Solution"

Another interesting innovation occurred in connection with the presentation of the Annual MTI Achievement Award. This Award was presented this year during the ASM Annual Awards Luncheon on Tuesday, October 28th, instead of during the regular Annual Meeting of the Institute.

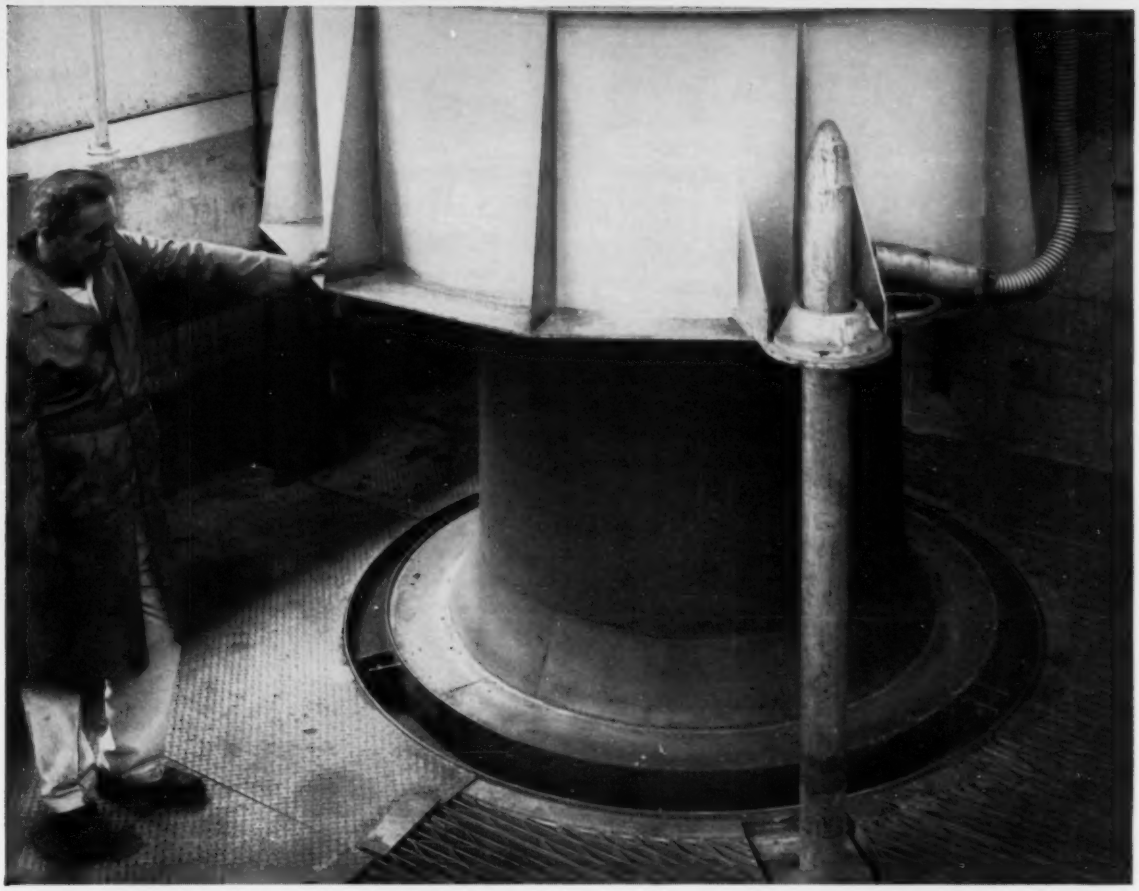
This Award is made annually to the author of the most outstanding lecture presented at the previous Annual or Spring Meeting or for any feature article appearing in the magazine *Metal Treating* during the preceding year's issues.

This year the Award was won by Mr. Michael P. Rivera of the Vacuum Equipment Division of The New York Air Brake Company, for

(Continued on page 39)



Mr. Michael P. Rivera of the Vacuum Equipment Division of the New York Air Brake Company, Camden, N. J. (left) is presented with the Annual MTI Achievement Award Plaque by Institute President K. U. Jenks. This Award was presented this year at the ASM Annual Awards Luncheon during the week of the Metal Show.



Hard to destroy! Easy to get! Long-lasting Inconel alloy retorts like this one at Harvey Aluminum, used for preheating, austenizing, quenching and tempering, can be produced by your regular heat treating equipment fabricator.

After 15 months of 1875°F heat treating...

Inconel Retort at Harvey Aluminum proves fully as good as it looks

Light, fast-heating retorts of wrought Inconel* nickel-chromium alloy prove amazingly durable.

Here (above) is one of several retorts at the Harvey Aluminum, Torrance, California plant which demonstrate the point. It was fabricated by California Alloy Products.

In service, retort is heated in a hurry . . . held there several hours . . . then cooled rapidly to one or two hundred degrees. Up again. Soak again. Down again. Cycle after cycle. All the while retort is under attack by atmospheric and furnace gases.

Harvey Aluminum, one of the major producers of wrought aluminum mill products, has many good words to say about the dependability of their wrought Inconel retorts. And about the high quality and long life of extrusion and forging dies produced in them. Die surfaces are excellent. Distortion is minimum. Shapes can be intricate.

Takes on many tough jobs

Where conditions are severe as in neutral salts bath pots, for example, or vertical furnaces, or tool carburizing baskets, or burning tools, or any one of thousands of items of heat treating equipment . . . Inconel alloy provides the dependability needed for profits and quality.

For the latest ways to shave costs with long-lasting Inconel alloy equipment, write Inco for "Keeping Costs Down When Temperatures Go Up."

*Registered trademark

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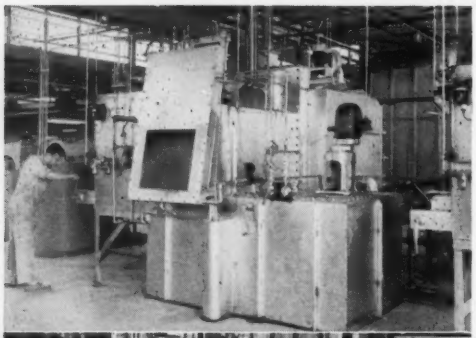
INCO NICKEL ALLOYS

WHEN IT COMES TO HEAT TREATING—
"Do-It-Yourself" can sometimes be costly

Buying equipment and supplies to perform heat treating operations within your own plant is only one step in many that must be considered when contemplating the installation or expansion of a heat treating department.

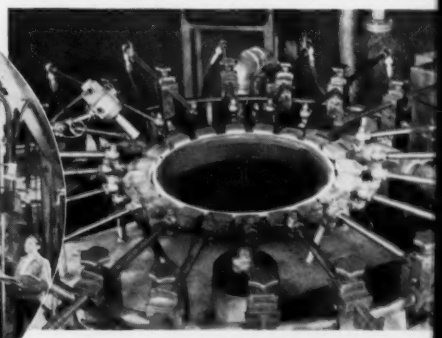


Here are some of the factors that should be included when figuring the cost of operating your own heat treating department—of "doing-it-yourself" when it comes to heat treating:

- **Technical skill:** Trained operators whose skill is the result of years of experience are essential
- **Maintenance:** Rapid deterioration of equipment occurs unless there is constant repair, maintenance, and skillful handling of the equipment
- **Quality control:** Testing equipment and skilled operators are necessary to maintain uniformity and quality control of all heat treating operations
- **Sufficient equipment and supplies:** A great variety of equipment is needed to meet the requirements of annealing, brazing, hardening, carburizing, stress relieving, nitriding, and all other heat treating processes; and an endless variety of materials and supplies must be kept on hand.

These problems and many more have been solved by commercial heat treaters. They have the answers because heat treating is their business.

Every MTI commercial heat treater listed here is a specialist with complete service facilities under one roof. Each one has the facilities, equipment, skill and experience which will enable him to meet your most exacting heat treating requirements.



When you have heat treating problems or need heat treating services . . . write

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FOR THE BEST IN COMMERCIAL HEAT TREATING—
Consult these companies:

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Southern Metal Treating Co., Inc.
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Hollywood Heat Treating Co.
1041 N. Mansfield Ave., Los Angeles 38
Lindberg Steel Treating Co.
2910 S. Sunol Drive, Los Angeles 23
Cook Induction Heating Co.
4925 East Slauson Ave., Maywood

CONNECTICUT

Commercial Metal Treating, Inc.
89 Island Brook Ave., Bridgeport 6
Stanley P. Rockwell Co.
296 Homestead Ave., Hartford 12
Ireland Heat Treating Co.
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Accurate Steel Treating Co.
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1630 Locust Street, Anderson

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New England Metallurgical Corp.
475 Dorchester Ave., South Boston 27
Porter Forge & Furnace, Inc.
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Springfield Heat Treating Corp.
99 Margaret Street, Springfield
Greenman Steel Treating Co.
284 Grove St., Worcester 5

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Lincoln Heat Treat, Inc.
21235 John R, Hazel Park
Royal Oak Heat Treat, Inc.
21419 Dequindre, Hazel Park
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Lindberg Steel Treating Co.
650 East Taylor Ave., St. Louis 15
Paulo Products Co.
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American Metal Treatment Co.
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Benedict-Miller, Inc.
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L-R Heat Treating Co.
107 Vesey St., Newark 5
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391 Pearl St., New York 38
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962 Main Street, E. Rochester 5
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Syracuse Heat Treating Corp.
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Lakeside Steel Improvement Co.
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George H. Porter Steel Treating Co.
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Metlab Company
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Gulph Road, King of Prussia
Pittsburgh Commercial Heat Treating Co.
49th St., and A.V.R.R., Pittsburgh 1
Pittsburgh Metal Processing Co., Inc.
1850 Chapman Street, Pittsburgh 15

TEXAS

Dominy Heat Treating Corp.
P. O. Box 5054, Dallas
Superior Heat Treating Co., Inc.
P. O. Box 69, Fort Worth 1
United Heat Treating Company
2005 Montgomery Street, Fort Worth 7
Cook Heat Treating Co., of Texas
6233 Navigation Boulevard, Houston 11
Houston Heat Treating Company, Inc.
2100 Quitman Street, Houston 26
Lone Star Heat Treating Corp.
5212 Clinton Dr., Houston 20

WISCONSIN

Allied Metal Treating Corp.
P.O. Box 612, Milwaukee 1
Metal Treating, Inc.
720 South 16th St., Milwaukee 4
Supreme Metal Treating Co.
4440 West Mitchell St., Milwaukee 14
Thurner Heat Treating Co.
809 West National Ave., Milwaukee 4
Wisconsin Steel Treating & Blasting Co.
1114 South 41st Street, Milwaukee 15
Harris Metals Treating Co.
4100 Douglas Ave., Racine

CANADA

Ipsenlab of Canada Limited
27 Bermondsey Road, Toronto 16, Ont.

REATING INSTITUTE

MASTER CRAFTSMEN
METAL TREATING INSTITUTE

VENUE NEW ROCHELLE, NEW YORK

or consult the M.T.I. members listed above

NEWS TO HEAT TREATERS...

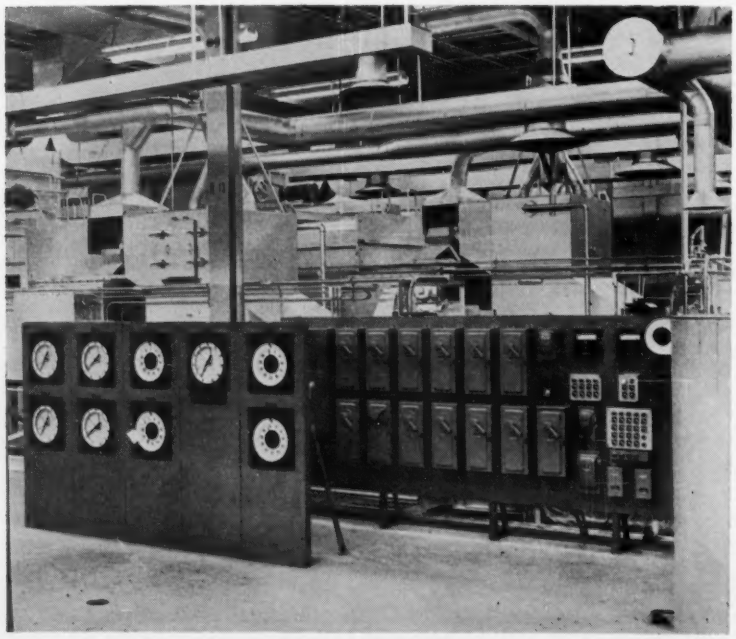
NEW HEAT TREATING DEPARTMENT

After nearly fifty years of manufacturing hex-socket screws and related products in downtown Hartford, Conn., The Allen Manufacturing Company is settled in its new plant, on a 32-acre site in Bloomfield, about seven miles from Hartford.

The plant's large, specially-engineered, heat treating department features new Holcroft heat treating units that harden, quench, wash, and temper in a continuous automatic operation, and a new AGF rotary furnace for carburizing dowel pins. New equipment also includes two industrial washing machines which wash the products after each operation and before heat treating. This equipment is combined with a vibrating de-chipper which removes metal particles that may adhere to products during processing.

The photograph shows the heat treating furnaces controlled by a battery of Minneapolis-Honeywell regulators which record processing data automatically.

For further information circle No. 1



ROCKFORD METALLURGICAL GROUP TO HOLD ANNUAL DISPLAY MEETING

In promoting the continued success of the educational program sponsored by the Rockford Chapter of the American Society for Metals, the Chapter will entertain the graduates of its current program in metallurgy and heat treating at an open meeting on March 25.

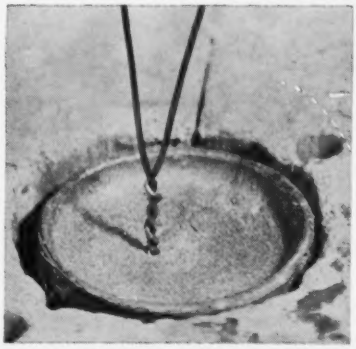
Opening immediately after luncheon on that date, a diversified program of metallurgical and heat treating interest will be moderated by local member metallurgists, terminating in a banquet at the Hotel Faust Grand Ballroom after which the featured speaker will be Dr. A. E. Focke, Manager of Materials and Development, Aircraft Nuclear Propulsion Project of the General Electric Company, whose topic will be "Materials Problems in the Nuclear Engineering Field". Intermediate coffee talk will be by Dr. Leland Carlson, President of Rockford College.

In conjunction with the event, local and area firms will sponsor displays of products and services, with personnel in attendance for discussion and explanation of exhibits. The exhibits and technical sessions will be open to the interested public.

For further information circle No. 2

ULTRASONIC FLUXLESS BRAZING

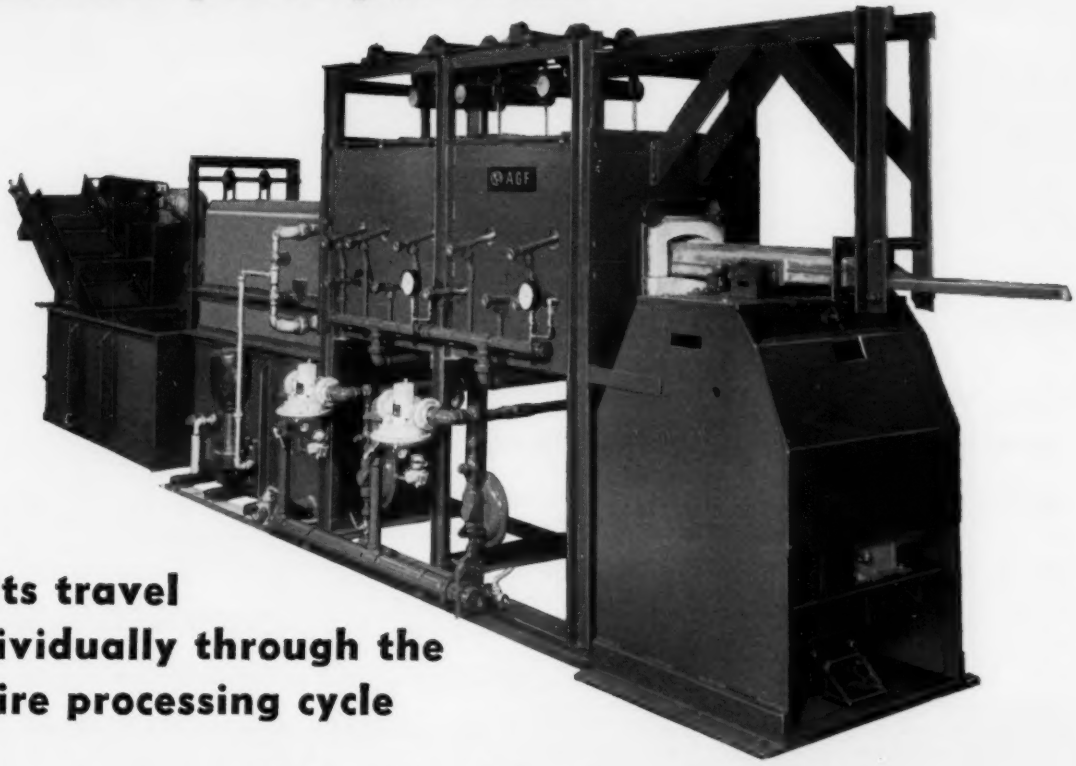
Aeroprojects Incorporated, West Chester, Pa., recently held an "Open House" where their ultrasonic equipment for brazing, soldering, and welding was demonstrated.



Of particular interest to our readers is the equipment for the application of ultrasonics to brazing techniques. Ultrasonic brazing is an extension of the ultrasonic soldering process. Brazing is used where joining metal with a higher melting point is required or where strength or corrosion problems are encountered with soldered joints. Applications of brazing are limited at present to fluxless brazing of aluminum, copper and similar materials, using aluminum-silicon or alumi-

(Continued on page 36)

Consistent Uniformity as you Bright Harden and Bright Anneal at 1850° — 100 pounds of stainless parts per hour!



Parts travel individually through the entire processing cycle

AMERICAN GAS FURNACE CO. 80 YEARS OF PIONEERING 1878 1958 ELIZABETH, N. J.

This new Shaker Hearth employs an alloy muffle which incorporates a purging, heating and water-jacketed cooling section, and seals into an automatic conveyorized oil tank.

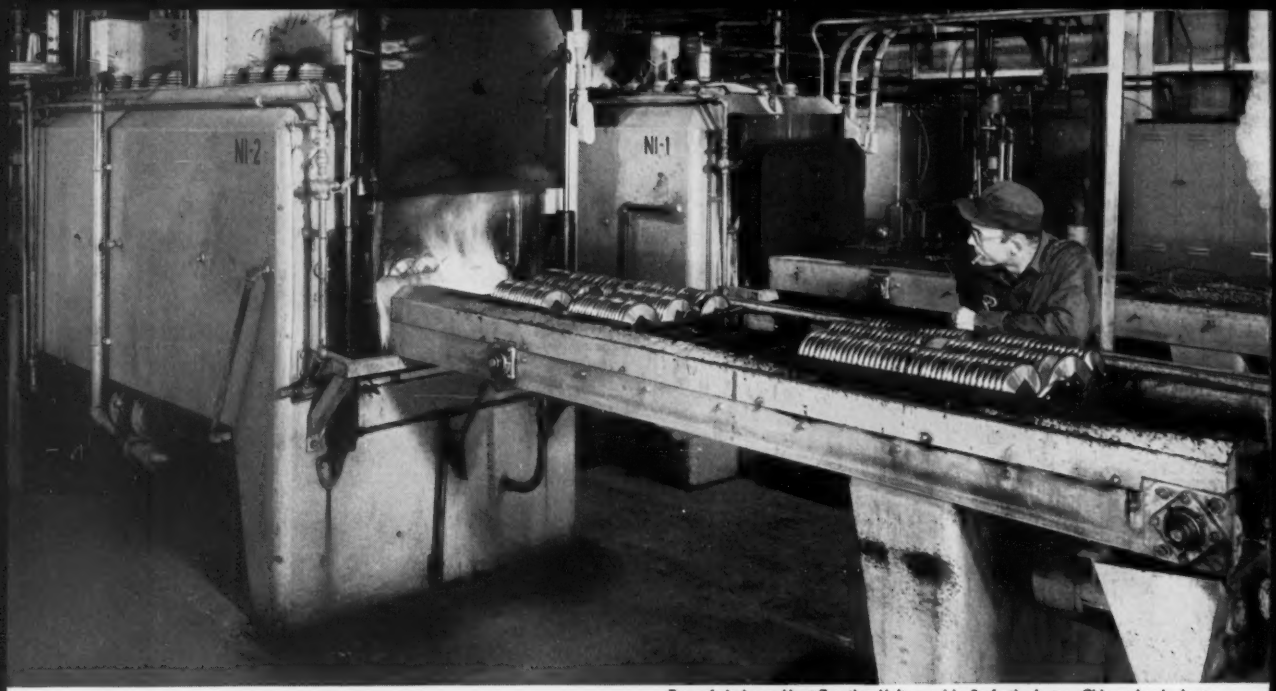
Among the many operational advantages of this new line of Reciprocating Furnaces, are the maintenance of —80° to —90° F. dew points . . . complete atmosphere uniformity throughout the processing cycle . . . and a very low consumption of atmosphere gas . . . Batch purging, heating and cooling are eliminated . . . and the parts may be observed throughout the entire processing cycle through openings in the charge and discharge ends of the muffle.

Write for Equipment Catalog #8A.

AMERICAN GAS FURNACE CO.

808 LAFAYETTE STREET — ELIZABETH 4, N. J.

"Pioneers since 1878"



Two of six Ipsen Heat Treating Units used in Perfection's two Chicagoland plants

"...with Ipsen heat treating units, we get bright work, and increase production per man-hour."

Perfection Tool and Metal Heat Treating Co.

Don Petersen is president of Perfection Tool and Metal Heat Treating Company, one of Chicago's largest and best known custom heat treating organizations. To learn firsthand how and why Perfection uses semi-automated, controlled atmosphere, heat treating equipment, we had an interesting chat with Mr. Petersen. Here are his answers to our questions:

Q. Since 1951 you have purchased a number of Ipsen "straight-through" heat treating units. Why have you favored this equipment?

A. We were well pleased with the first Ipsen furnace we bought, and our customers were well satisfied with the quality of the work that came out of it. Since the end of World War II, there has been a much greater demand for atmosphere work, and, as this demand increased, we have purchased additional furnaces. We have four Ipsen units in our Hubbard Street plant . . . and two in our branch plant in Lombard, Illinois. All six units have two work chambers which make them ideal for preheating.

Q. What kind of work do you handle in your Ipsen equipment?

A. In the course of the average day we handle many, many different types of work . . . gears, screw machine parts, stampings, etc. We use your furnaces for carburizing, carbonitriding, neutral atmosphere hardening, and carbon restoration. The versatility of Ipsen furnaces is quite a selling point as far as we are concerned.

Q. Have you been able to increase production with this equipment?

A. Yes. With Ipsen equipment we have substantially increased production per man-hour. One reason for this is that quenching is automatic . . . and our operators do not have to handle parts in and out of the quench by hand.

Q. Apparently you like the automatic quench feature. Why?

A. Definitely. The automatic timing makes it easy to duplicate previous quenching results. We eliminate the element of human error in quenching.

Q. What about maintenance of your Ipsen equipment?

A. You have an excellent record on this count. We find that your equipment requires very little maintenance.

Q. What do your men think of Ipsen equipment?

A. Our men like your equipment because it's cleaner, cooler, and easier to operate. It takes less effort per pound of work treated.

Q. Has Ipsen equipment permitted you economy of floor space?

A. Yes. We find your equipment to be quite compact for the amount of work handled. In our Hubbard Street plant four Ipsen units are placed so the discharge ends converge on the same washing and degreasing unit. The entire installation occupies only 600 sq ft of floor space.

A brochure describing the type of Ipsen equipment used in the Perfection plants is available. Ask for your copy.

AUTOMATIC Ipsen HEAT TREATING UNITS

IPSEN INDUSTRIES, INC. • 135 S. MAIN STREET • ROCKFORD, ILLINOIS

LETTERS TO THE EDITOR

Dear Sir:

In the past year and particularly the last several months, several references have been made to the "Martempering process for fixture quenching punches" which was described in an article that has appeared in the 1955 November-December issue of your magazine under Heat Treating Hints.

We would like to obtain a copy of the article, if at all possible, so that we might fully utilize the information contained therein.

G. M. Slakis,
Toolroom Analyst,
Western Electric Co., Inc.,
Chicago, Ill.

Dear Editor:

Please advise me if I may receive a regular copy of your publication "Metal Treating."

Much valuable information is available to Heat Treaters through your publication. Thank you.

Robert M. Haefeli
Sunnyvale, California

Gentlemen:

I have seen several copies of your magazine, "Metal Treating." It contains information that I believe would be valuable in assisting me in my job in the Heat Treat Department.

G. N. Calkin
International Business Machines Corp.
Endicott, N. Y.

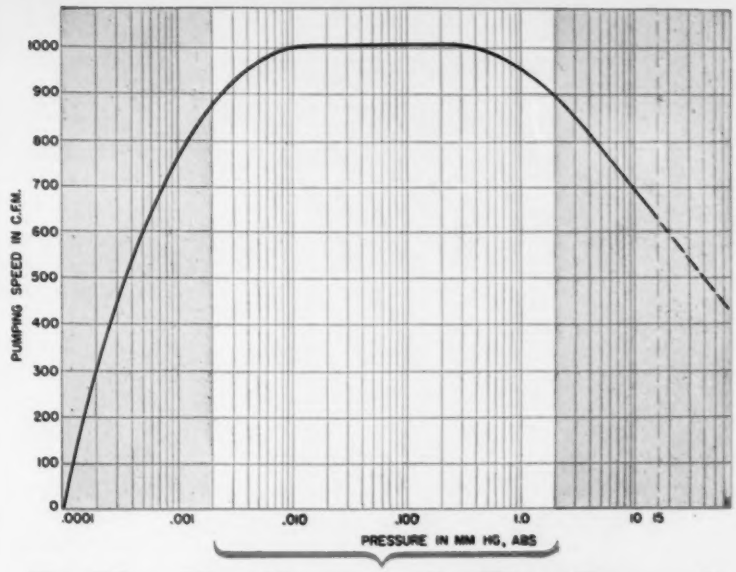
Dear Sir:

I have recently had the opportunity to read your "Metal Treating" publication and was very interested in the material it contained.

Because I am a metallurgical engineer actively working in our heat treating section, I would appreciate your putting my name on your mailing list.

Paul Weil,
Manufacturing Engineer,
Westinghouse Electric Corp.
Philadelphia, Pa.

(Continued on page 41)



Do You Use Vacuum In This Range?

From millimeters to microns . . . in this region the significant economy of the KINNEY KMB Mechanical Booster Pump is self-evident, as shown by the performance curve above. And, this high efficiency is doubly attractive because these KINNEY Pumps provide clean, dry Vacuum . . . no backstreaming . . . automatic operation . . . no stalling problems from gas bursts.

Kinney®

MECHANICAL BOOSTER HIGH VACUUM PUMPS

The KINNEY KMB Pumps have proven themselves in the most difficult applications. They feature high pumping speed in the low micron range and their design provides for addition of interstage cold traps with minimum plumbing or other complications. Their performance, even where outgassing of materials renders other pumps inoperative, stamps them as the major contribution of the decade in High Vacuum service.

KMB 1200 with free air displacement of 1230 cfm. Other models provide pumping speeds from 30 cfm to 5100 cfm.

WRITE for Bulletin No. 3180.1 It's FREE

KINNEY MFG. DIVISION
THE NEW YORK AIR BRAKE COMPANY
3594 B WASHINGTON STREET • BOSTON 30 • MASS.

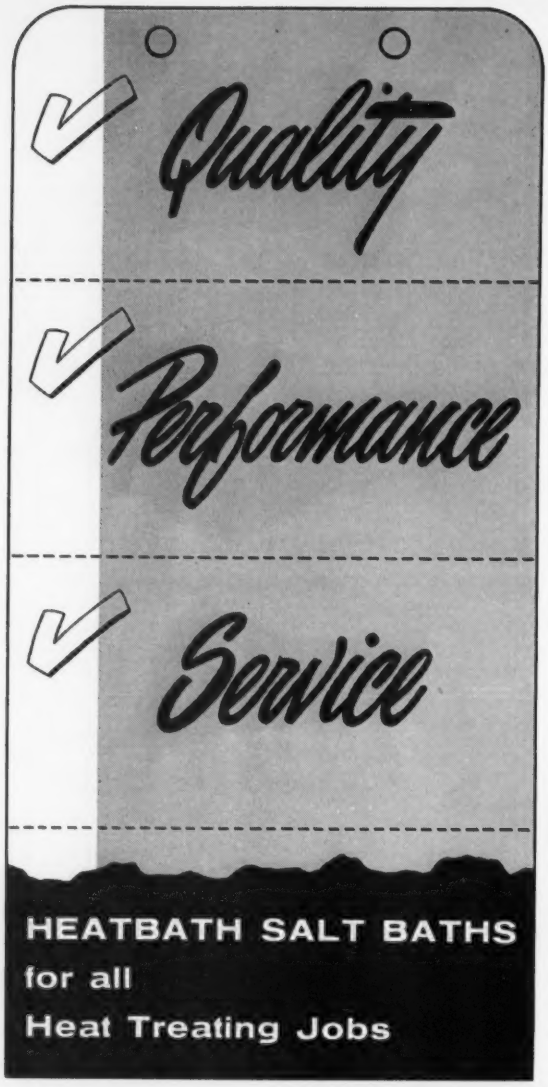
Please send me copy of Bulletin No. 3180.1 describing KINNEY KMB High Vacuum Pumps.

Name_____

Company_____

Address_____

City_____ Zone_____ State_____



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MARTEMPERING

HEATBATH CORPORATION
Springfield 1, Massachusetts
or 701 North Sangamon Street, Chicago 22, Illinois
36 Years of Service to the Heat Treating and Metal Finishing Industry

MISSILE FURNACE

(Continued from page 16)

the protection of parts during heating and quenching cycles.

Duplicates of all control and recording devices will be available for the operation of the system in the event of instrument failures.

Safety devices are being installed to minimize any damage that might occur due either to equipment malfunctions or personnel mistakes. For example, interlocked limit switches will make it impossible to lower a load into the draw furnace when its top is covered; and the oil quench tank will have a double-shot carbon dioxide unit for fire protection.

As indicated by accompanying photographs (see Figs. 1 and 2), Pacific Scientific has had a scale model of the Gantry heating system constructed. Its parts include not only such fine details as piping and control levers, but building structural members which imposed dimensional limitations on the system's design. Further, it can be put through most of the mechanical movements that its full-scale counterpart will undergo.

Because it will allow potential sub-contractors to visualize work to be done, and thus to pare their estimates to the bone, the model is expected to reduce installation expenditures by a margin that should exceed its cost several times. • • •

How to Cut Pot Costs:

Buy low-cost Eclipse pressed (not welded) steel pots . . . and replace them on a regular schedule. You'll save through:

1 Lower initial cost
2 Elimination of failures
3 Faster, more even heating
4 Quantity discounts earned on your total purchases in any 12-month period

Guaranteed free from defects. Write:.
ECLIPSE FUEL ENGINEERING COMPANY
Industrial Combustion Division
1018 Buchanan St., Rockford, Ill.

Eclipse PRESSED STEEL POTS

Export: Ad Auriema, Inc., 85 Broad St., N.Y.C.

(Continued from page 3)

out that he considers gas more economical and maintenance-free, but these factors have been outweighed by the ability of a certain electric furnace maker to produce superior quality on this company's particular work. These people also stated that electric units were better for worker comfort, but they were comparing gas units 20-30 years old with new electric ones. Also, according to their opinion, it was easier to install a gas furnace with their own labor by bringing in or extending a pipe line and making a simple connection, whereas for an electric unit, the need for a new power line usually entailed an outside contractor, elaborate terminal boxes, and thus greater expense.

A long-established commercial heat treater in a part of the Midwest, a section of the country where quality standards are high and competition on costs is very keen, has the usual story to tell concerning energy cost and upkeep. His equipment, as a result, is about 90% gas. However, he, too, has certain specific instances where electric heat has proven desirable. One of these is in a tempering operation where moisture from the condensation of the products of combustion in a gas unit causes undesirable oxidation or rusting before the work is really hot.

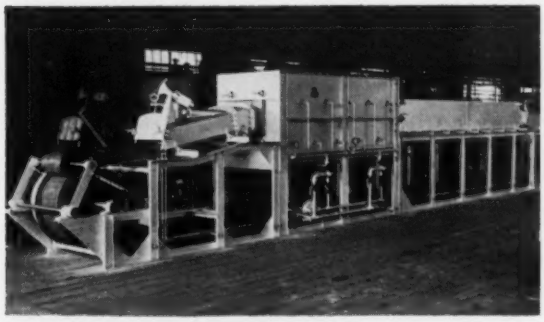


Fig. 5—For some heating processes, metal muffles must be used in all furnaces. In mechanized furnaces of this type, the heating system must be simple and reliable as in this gas-fired unit.

Considering many of the points raised by such a cross section of users, as well as others, we can now enumerate a few of the selection factors and discuss them individually (not necessarily in the order of their importance).

Initial Cost: It would appear that, for anything except the most simple furnace, costs for electric furnaces and gas furnaces are not very different, gas having a slight edge.

Installation Cost: If general room-type venting is used on the gas furnace, it is the general consensus that gas is easier, especially with "in-plant" help, although differentials are not great.

Maintenance Cost: In most instances, experience indicates that this is one of the greatest deciding factors, and is greatly in favor of gas. This may be changed in the future with newer designs.

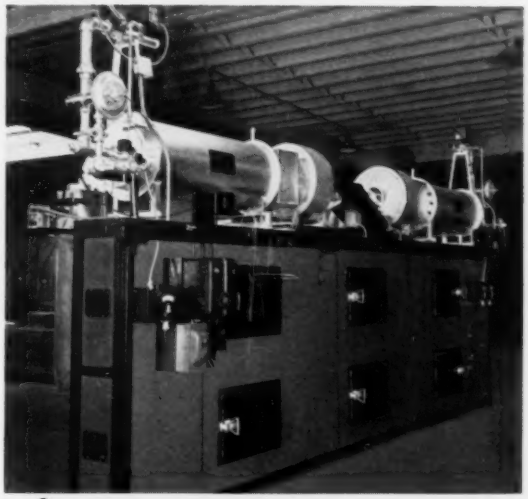
(Continued on page 48)

Genrich & Genrich Gas-Air Heaters use

GARDEN CITY

High Temperature Fans

on ovens that bake insulating varnish on wire



This is an installation of ovens with Garden City fans drawing the air thru gas-air heaters. The air is taken from the oven, mixed with fresh air, heated by the heater. Then the Garden City fans blow the heated air back into the oven.

All over industrial America today, durable, corrosive-resistant Garden City fans are moving air and gases up to 1850°F. For furnaces, ovens and kilns, Garden City's new RF THERMAL-AIRE fans do an incomparable job. Ask us about them.

Write Today For New Catalog

or let our engineers help you on your special problem.

GARDEN CITY FAN COMPANY
ESTABLISHED 1879

801 No. Eighth St. Dept. T. Niles, Michigan

Representatives in Principal Cities

• Fans for Industry • Backward Curve • Forward Curve
• Material Handling • Radial Bladed • Small Exhaust

NEWS TO HEAT TREATERS

(Continued from page 30)

num-braze metals with a melting point in the range of about 800° to 1250°F. The physical and mechanical problems associated with ultrasonic brazing are similar to those of ultrasonic soldering.

Brazing has been used to join heavy gage insulated aluminum and copper wire without pre-stripping the insulation. Most satisfactory results are obtained on wires insulated with Formvar and enameled materials. Joints so produced have excellent strength, electrical conductivity, superior ductility and good corrosion resistance. Standard EC aluminum alloy used as a brazing material produces the most ductile joint.

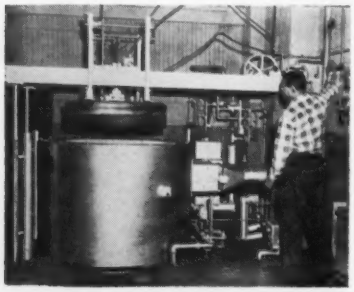
The photographs show a brazed connection of two enameled insulated aluminum wires and a close-up of the brazing head used to join the wires. In this application the ultrasonic brazing head is in an inverted position and the active tip is hollowed out to form a brazing pot. EC aluminum alloy is used as the braze material at a temperature of 1150° to 1200°F. The wires are dipped into the brazed material without pre-stripping the insulation and exposed to the ultrasonic energy approximately one second. The vibratory energy breaks up the insulation and oxides, and excellent joints are said to be obtained.

A bulletin entitled *Sonobraze* describing and illustrating the process is available.

For further information circle No. 3

PIT-TYPE FURNACE

An electric products manufacturing company uses a pit-type heat treating furnace in its actual production area.



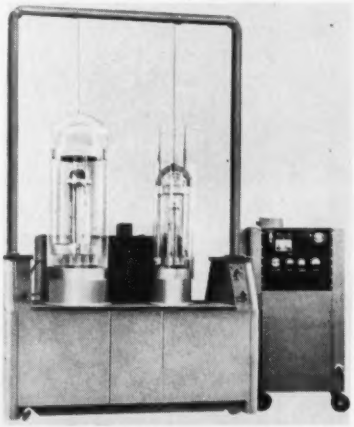
The furnace, built by Surface Combustion Corp., Toledo, Ohio, has a temperature range from 400° to 1800°F and can handle three 550-pound coils simultaneously.

The heat treatment furnishes required surface finish and physical and electrical properties to the copper alloy coils which are usually about 26" in diameter and are components of electric motor commutators.

For further information circle No. 4

INDUCTION BRAZING

Brazing sensitive metal parts by the use of high frequency induction in a hydrogen atmosphere has a number of advantages. One advantage is that by using a bell jar and feeding the gas in from the top only a very small amount of gas is used; only that which flows out through the bottom. At the same time, by using induction, the heat can be highly localized and the progress of the heating can be viewed from the outside through the bell jar. Hydrogen acts as a flux when brazing is done at a sufficiently high temperature and acts as a protective agent at low temperatures, even as low as soft soldering temperatures.



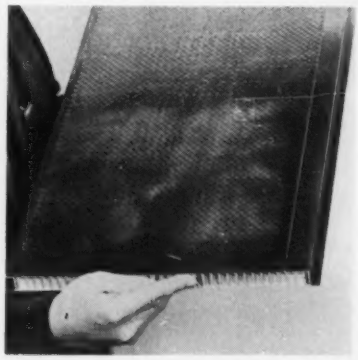
The photo shows a new and advanced double hydrogen induction brazing furnace supplied by Radio Frequency Company, Inc., at Medfield, Mass., to the Sandia Corporation, Contractor for the AEC, Albuquerque, New Mexico. With this setup, large parts can be brazed in an atmosphere of hydrogen or various mixtures of hydrogen and other gases or helium, argon, nitrogen, etc.

This unit can be used for special types of zone refining as well as brazing. Floating zone refining, in particular, is accomplished quite easily on RFC Induction Units due to their very high flux density which tends to support the zone. Radio Frequency Company, Inc., construct Induction Units up to 120 megacycles in frequency for highly specialized advanced applications. At 120 megacycles, the very pure silicon and some of the thyrites and other unusual materials can be zone refined.

For further information circle No. 5

NEW VACUUM BRAZING PROCEDURE

High-vacuum atmosphere eliminating the need for inert gas, avoiding welded envelopes, rapid loading and unloading, and fast cooling are features of the new vacuum brazing procedure for honeycombs developed by F. J. Stokes Corp., Philadelphia, Pa.



The company will build this honeycomb brazing equipment in the form of complete package systems, incorporating the refinements drawn from its experience in building vacuum heat treating furnaces and other high-vacuum metallurgical equipment.

Stokes' experience claims that this vacuum-brazing procedure could turn out work rapidly, with cycles running under three hours from cold start to cold finish.

The equipment is said to operate satisfactorily at 1700°F, high enough for all present honeycomb work, and can be operated successfully at higher temperatures.

For further information circle No. 6

(Continued on page 44)

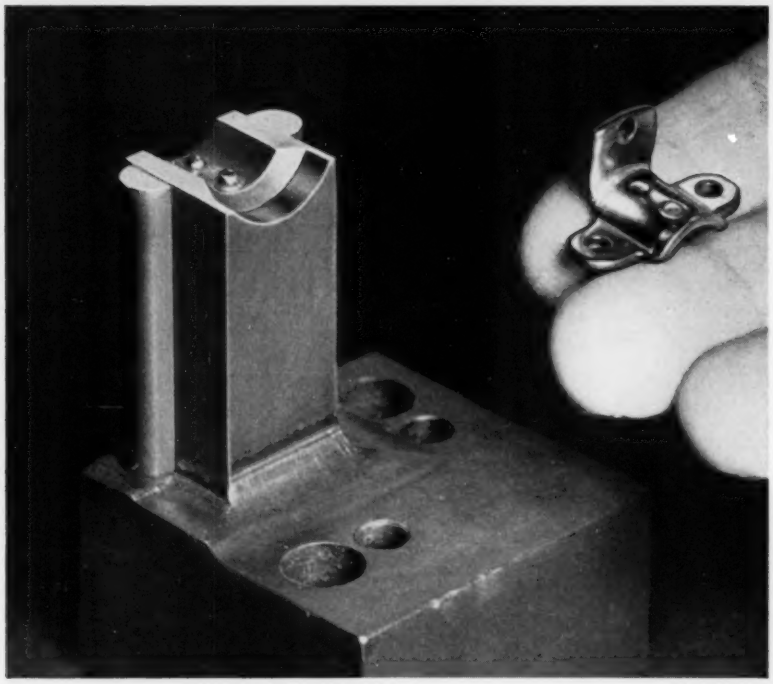
Tool Steel Topics

BETHLEHEM STEEL

In the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributor: Bethlehem Steel Export Corporation



1½ million pieces with Lehigh H ...that's a long run in any league!

At Harvey Hubbell, Inc., Bridgeport, Conn., they were using a competitive grade of tool steel to form cord-clamp sections made from Grade 1010 steel strip. But each time they hit an average figure of 700,000 pieces, the die cracked, and had to be replaced. The manufacturer decided to call in Lindquist Steels Inc., a local distributor of Bethlehem tool steel.

"With the finished part only .060 in. thick, we ought to do better than 700,000 pieces. What do you suggest?"

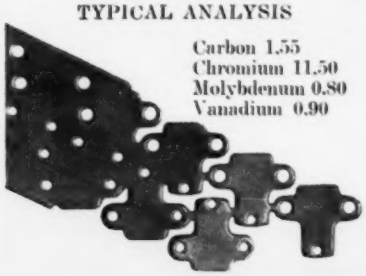
The distributor studied the operation, the cracked die, and the finished part. "I'd recommend Lehigh H," he said. "It has the strength you need in a forming operation of this sort." The Lehigh H was put on the job and produced 1½ million pieces without any trouble.

Lehigh H is our high-carbon, high-chromium, air-hardening tool steel. It's a grade with outstanding wear-resistance and toughness. And it's also a deep-hardening steel with high compressive strength.

The best way to evaluate Lehigh H is by putting it to work—not in an easy job, but in a tough one. Your Bethlehem tool steel distributor carries Lehigh H in stock, and will see that it's delivered promptly. Get in touch with him.

TYPICAL ANALYSIS

Carbon 1.55
Chromium 11.50
Molybdenum 0.80
Vanadium 0.90



BETHLEHEM TOOL STEEL ENGINEER SAYS:

Don't Use Fresh Water For Quenching Tools

Fresh water, regardless of its source, contains dissolved gases which make it unsuitable for quenching tools. When tools are quenched in fresh water, gas is liberated at the surface of the tool. Gas pockets thus formed may prevent contact between tool and water, resulting in soft spots from ineffective quenching. Soft spots are undesirable because of their low hardness, and also because a quench which produces them may also cause cracking of the tools.

Soft spots, and tool cracking associated with soft spots, can be avoided by quenching in water which has been previously boiled, to remove the dissolved gases. If water cannot be boiled, quench a large amount of hot "dummy" material to expel the gases. As a further precaution against soft spots, it is preferable to use a 10 pct brine solution instead of water. It is also suggested that the dissolved gases be expelled from the brine solution before use.

USE DURAMOLD FOR COLD-HOBBING

Bethlehem's Duramold tool steels, in Grades A and B, are ideal for cold-hobbing plastic dies because they are free from injurious surface and internal defects. Duramold A, an air-hardening grade, is annealed to 109 max Brinell. Duramold B hardens in oil, and hobs more readily than Duramold A. It is annealed to 100 max Brinell, and has an addition of boron to increase the core strength.

HEAT TREATING HINTS

(Continued from page 22)

in a long manuscript, the enclosed reference list of available publications, all of which we have reviewed, should offer you a more complete file.

One last suggestion, which we feel is very worthwhile, is to contact the local fire department and invite the Batallion Chief and his men over to your plant. You can then acquaint them with your facilities and point out specific installations which you feel warrant special care in case of fire.

We trust that you will find these remarks of some help in your operation. If you have any further specific questions on a particular phase of safety in the heat treating plant, please let us know, and we will reply to the best of our ability.

(Signed) John H. Ries
General Manager

REFERENCES

1—"Blazes"—A. S. Eves, May-June Issue of *Metal Treating,* 271 North Avenue, New Rochelle, New York

2—Factory Mutual Publications—Factory Mutual, Engineering Division, 1151 Boston-Providence Turnpike, Norwood, Massachusetts—as follows:

11.88 Piping for natural and manufactured gas.
13.20 Flammable liquid safeguards.
13.21 Flammable liquid pumping & piping systems.
13.23 Storage tanks for flammable liquids.
13.48 Oil quenching of metals.
14.20 Industrial Furnaces.
14.56 F.M. Cock & Gas safety control system.
14.70 Flammable atmosphere hazards of Special Atmosphere Furnaces.
15.10 Maintenance of Electrical Equipment.
20.00 Installing Sprinkler Equipment.
24.02 Fire Extinguishers.
36.10 Properties of flammable liquids, gases and solids.
P-5620 CO_2 Hi Pressure Systems.

3—Report to management "Could a Fire Ruin Your Business?" Research Institute of America, Inc.—File No. 33

4—"Automatic Dry Chemical Unit for Small Installations". Ansul Chemical Company—Marinette, Wisconsin

5—"Fire Safety in the Small Industrial Plant". Industrial Commission of Ohio—Division of Safety & Hygiene

6—"Standards of the National Board of Fire Underwriters". Bulletin No. 10—National Board of Fire Underwriters, 85 John Street—New York 38, New York

7—"What to do about Metal Fires". *Iron Age*—November 21, 1957 Issue

8—"Prevent Lighting Off Explosions with Safety Controls". *Iron Age*—November 7, 1957 Issue

9—"The Use of Tetrathoxyboxorine for the Extinguishment of Metal Fires". Department of Commerce—Washington 25, D. C.

Here's why you can have confidence in America's future!

Family income after taxes is at an all-time high of $5300—is expected to pass $7000 by 1975. There's a new wave of opportunity coming and smart people are getting ready for it.

Sound Familiar?
HERE'S A BOARD PLANNING A PLANT (INCLUDING A DO-IT-OURSELVES HEAT TREATING DEPT!)
AND GENTLEMEN, OUR OWN METAL TREATING DEPARTMENT WILL KEEP OUR PRODUCTION 100% IN-PLANT.
SURE,-WHY GIVE THAT PROFIT AWAY!
HANK POELER
THE PROPOSED LIST OF EQUIPMENT AND SUPPLIES QUICKLY OPENS THEIR EYES!
ALL THAT EQUIPMENT,-JUST TO ANNEAL, BRAZE, HARDEN, CARBURIZE, STRESS-RELIEVE, NITRIDE, ETC, ETC, ETC.?
PLUS SUPPLIES!
ALL THAT VALUABLE FLOOR SPACE!
AND SKILLED LABOR!
P.S.-THE WORK WENT OUT TO A COMMERCIAL HEAT TREATER!

MTI ACTIVITIES

(Continued from page 26)

his article published in the November-December 1957 and January-February 1958 issues of *Metal Treating*. The article is entitled "Special Techniques in Vacuum Metallurgy."

Some outstanding talks and discussions were held during the technical session on Friday, October 31st. An MTI Panel Program took place, and three subjects were presented and discussed. The first title was "Settlement of Liability Claims," and the Discussion Leaders were Horace C. Knerr, John H. Ries, and Ben Rassieur. The second topic was "How to Make Use of the National MTI Wage Survey," the discussion being led by Charles H. Hewitt. The discussion of the third subject, "Need for Minimum Price," was led by Norman R. Hodgson.

Also at this session a color sound film was shown entitled "The Business You Built," which presented the story of the Dayton Forging and Heat Treating Company of Dayton, Ohio.

The session was concluded by the presentation of the Past President's Plaque to Mr. Howard N. Bosworth of Bosworth Steel Treating Co., Detroit, Mich., by President K. U. Jenks of Lindberg Steel Treating Co., Melrose Park, Ill.

Friday evening featured the Annual Reception and Banquet with entertainment provided by a floor show and dancing.

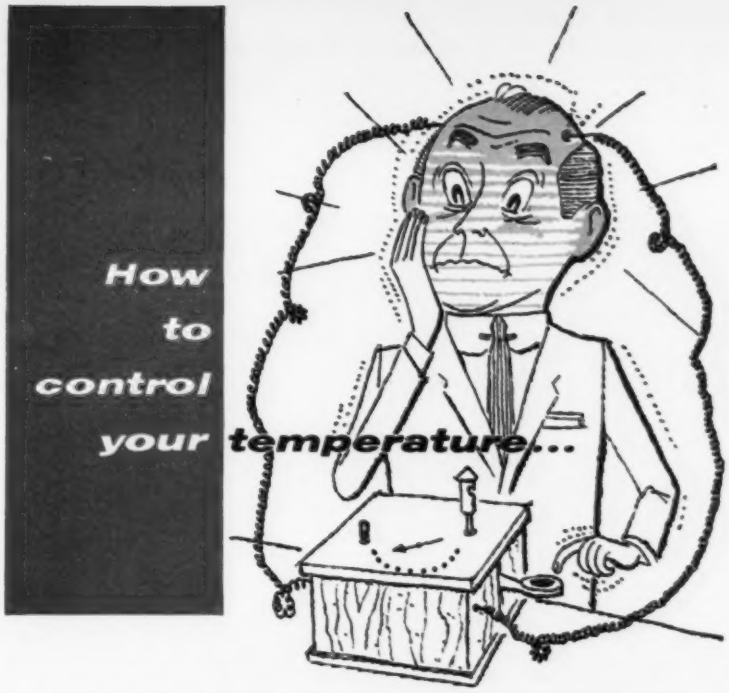
The following officers were elected at the business meeting on Saturday, November 1st:

President (re-elected for second term)
K. U. Jenks
Lindberg Steel Treating Co., Inc., Melrose Park, Illinois

Vice President
C. R. Weir
Commonwealth Industries, Inc., Detroit, Michigan

Treasurer (re-elected)
Lloyd G. Field
Greenman Steel Treating Co., Worcester, Massachusetts

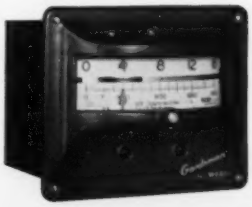
(Continued on page 41)



Your personal temperature may soar when you see the advantages that others gain by improving control of temperature in operations like yours. But you can confidently control both types of temperature by using our consulting service and, if necessary, some of our instruments.

For we are specialists in temperature control. Our worldwide field force is constantly working with situations like yours, seeking waste and hidden potentials where "control is no problem." Working with your own people, chances are they'll find ways to boost your production...assure quality... reduce costs.

We provide such service without charge, to determine whether you really need our indicators or controllers or recorders, thermocouples and accessories. Chances are that you do; for our instruments soon save their cost in avoiding work-stoppage and reducing maintenance.



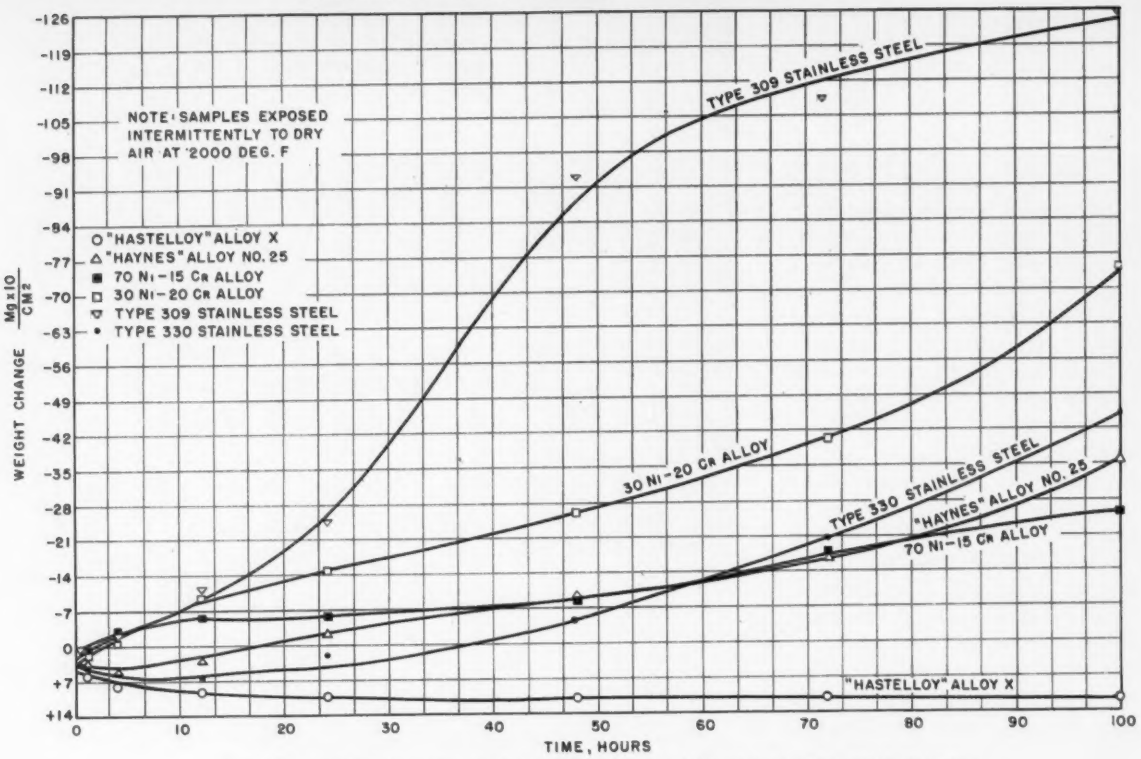
Gardsman Controllers

Model JL (shown) may be used as high-limit control with manual reset—as for heat treating—or alarm applications as well as off-on continuous control. Other models serve other purposes. All are tubeless, "solid-state" and proved in wide use. Phone your West consultant (see Yellow pages) or write Chicago office for Bulletin JL or for COM digest-catalog of line.

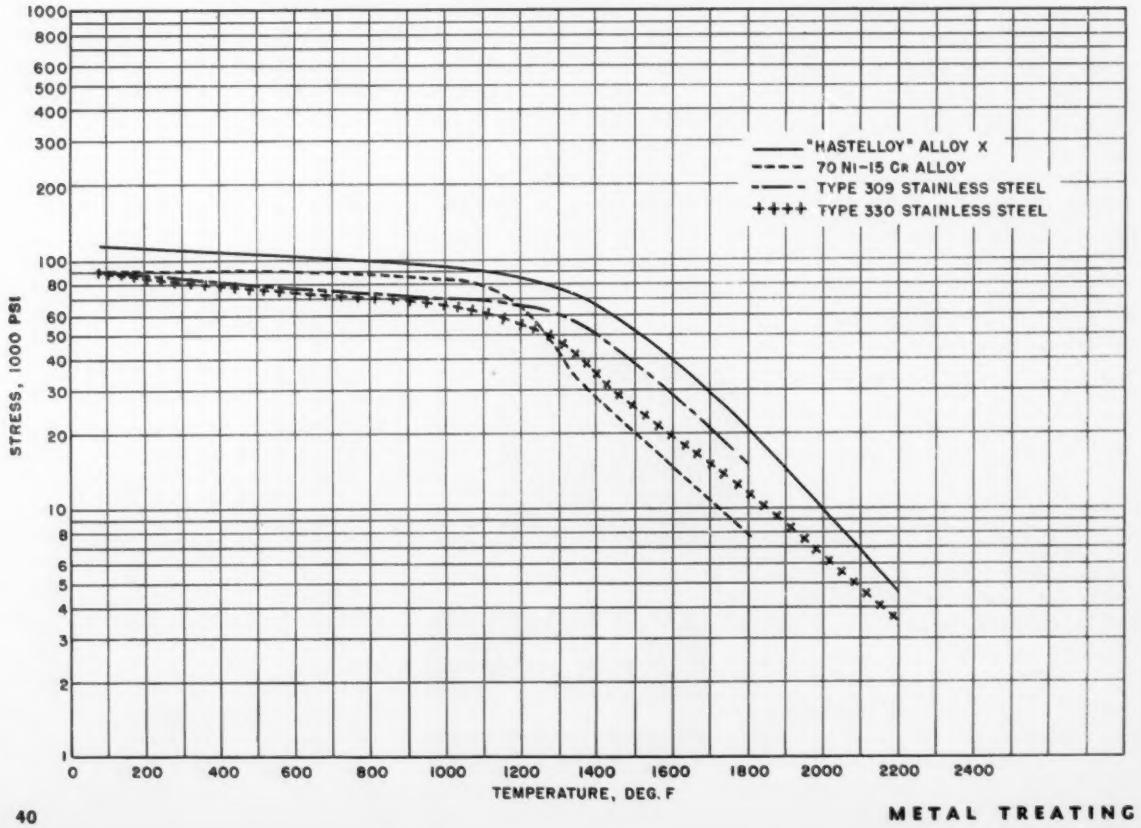
WEST Instrument CORPORATION
SALES OFFICES IN PRINCIPAL CITIES
FACTORY AND GENERAL OFFICES:
4363 W. MONTROSE, CHICAGO 41, ILL.
BRITISH SUBSIDIARY:
WEST INSTRUMENT, LTD.
32 Regent St., Brighton 1, Sussex

the trend is to **WEST**

OXIDATION RESISTANCE OF SEVERAL HIGH-TEMPERATURE ALLOYS


NOTE: SAMPLES EXPOSED INTERMITTENTLY TO DRY AIR AT 2000 DEG. F
○ "HASTELLOY" ALLOY X
△ "HAYNES" ALLOY NO. 25
■ 70 Ni–15 Cr ALLOY
□ 30 Ni–20 Cr ALLOY
▽ TYPE 309 STAINLESS STEEL
• TYPE 330 STAINLESS STEEL
TYPE 309 STAINLESS STEEL
30 Ni–20 Cr ALLOY
TYPE 330 STAINLESS STEEL
"HAYNES" ALLOY NO. 25
70 Ni–15 Cr ALLOY
"HASTELLOY" ALLOY X
WEIGHT CHANGE Mg x 10 / CM2
TIME, HOURS

TENSILE STRENGTH OF VARIOUS FURNACE ALLOYS AT ELEVATED TEMPERATURE



MTI ACTIVITIES

(Continued from page 39)

The following members of the Board of Trustees are serving the second year of their two-year terms:

Board of Trustees

A. L. De Hart
Fred A. Snow Co.
Chicago, Illinois

Clarence F. Graham
Metal Treating, Inc.
Milwaukee, Wisconsin

Howard N. Bosworth
Bosworth Steel Treating Co.
Detroit, Michigan

M. B. Dominy
Dominy Heat Treating Corp.
Dallas, Texas

Three new members of the Board of Trustees were also elected:

Board of Trustees

A. S. Raphael
Standard Steel Treating Co.
Detroit, Michigan

Elmer J. Cox
Pittsburgh Commercial Heat Treating Co.
Pittsburgh, Pennsylvania

John H. Ries
Lakeside Steel Improvement Co., Cleveland, Ohio

C. W. Derhammer

It is with deep regret that we announce the sudden passing in December of C. W. (Bill), Derhammer, President of Lakeside Steel Improvement Company, Cleveland, Ohio.

Lakeside Steel Improvement Company was one of the original members of the Metal Treating Institute and Bill was always an active supporter of the Institute.

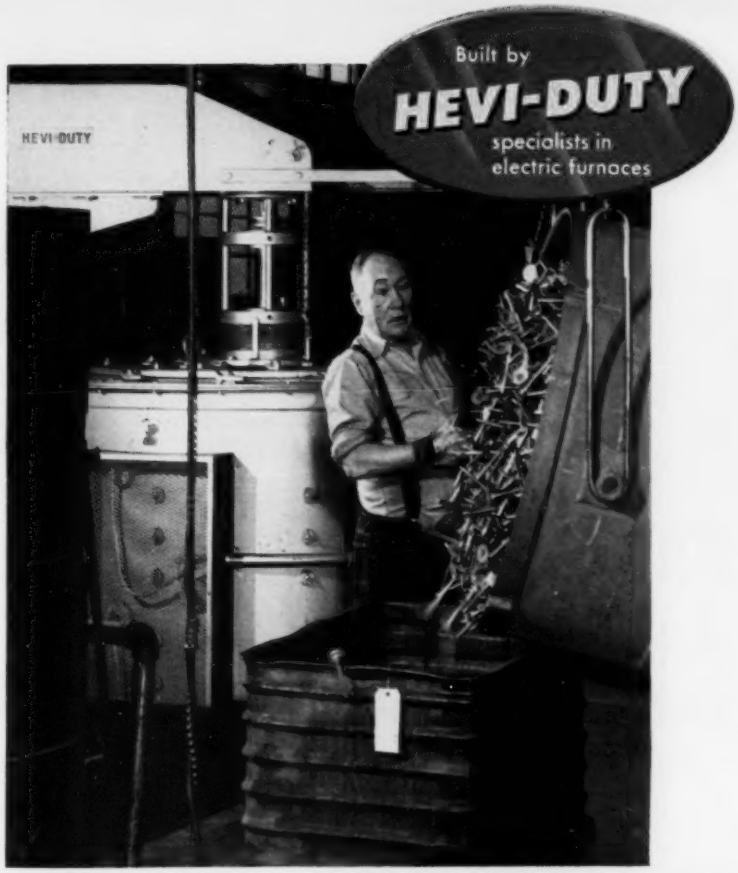
LETTERS TO THE EDITOR

(Continued from page 33)

Dear Sirs:

Having enjoyed the copy of "Meal Treating" which I received at the recent Metal Show, I would appreciate your adding my name to your mailing list.

John McKenna, Metallurgist
The Park Drop Forge Co.
Cleveland, Ohio



Here come 10,000 valves
...and all with uniform hardness

Even heat throughout a dense, 2,000-lb load... 10,000 uniformly hardened valves every time... valves free from distortion with no rejects.

Eaton Manufacturing Company's Valve Division in Battle Creek, Michigan, expects and *gets* performance like this from their Hevi-Duty pit furnaces. The furnaces are used 24 hours a day for the age-hardening of valves for automotive and industrial engines. An efficient baffle and fan system provides an even rate of heating throughout the dense load, adding to over-all uniformity.

Eaton purchased five small Hevi-Duty pit furnaces early in World War II. Exceptional performance by these furnaces led to the addition of larger units to meet increased demands. All units have given excellent service. None have required more than normal maintenance since installation.

If uniformity is important in your work, investigate Hevi-Duty furnaces. Write for Bulletin 646.

- Heat Processing Furnaces
- Dry Type Transformers
- Constant Current Regulators

HEVI-DUTY ELECTRIC CO.
Milwaukee 1, Wisconsin

(Continued from page 8)

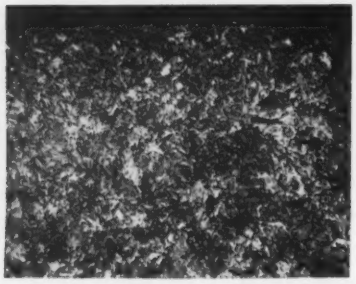


Fig. 12—Microstructure of 1117 Steel after carburizing for 3 hours at 1900° F and atmosphere cooled. Mag. 100 X - 2% Nital Etch.

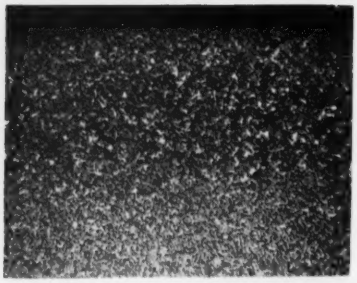


Fig. 13—Microstructure of 4615 Steel after carburizing for 3 hours at 1900° F and atmosphere cooled. Mag. 100 X - 2% Nital Etch.

Fig. 14—Microstructure of 8620 Steel after carburizing for 3 hours at 1900° F and atmosphere cooled. Mag. 100 X - 2% Nital Etch.

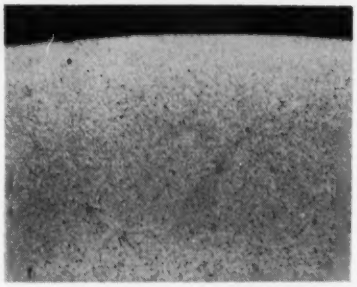


Fig. 15—Microstructure of 9315 Steel after carburizing for 3 hours at 1900° F and atmosphere cooled. Mag. 100 X - 2% Nital Etch.

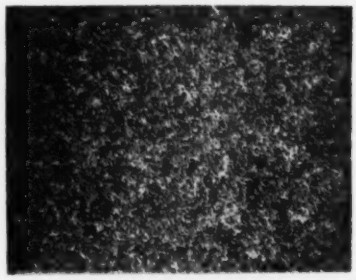
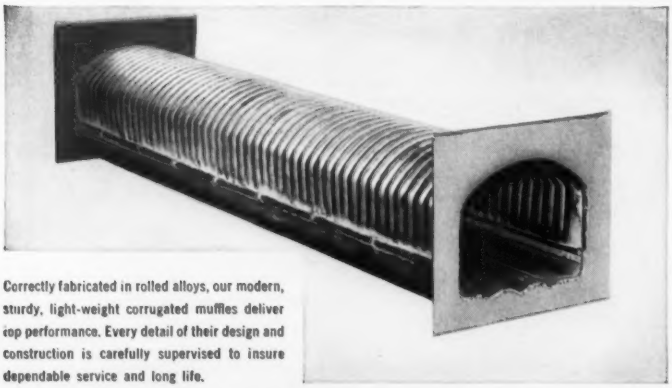


Fig. 16—Microstructure of the Core of the ½" Diameter 8620 Steel which had been carburized for 3 hours at 2000° F, atmosphere cooled, subsequently reheated to 1500° F and oil quenched. Mag. 100 X - 2% Nital Etch.

FABRICATED MUFFLES
Annealing Hoods, Retorts
that maintain high-heating efficiency

In keeping abreast with the development of controlled atmosphere furnaces for carburizing, annealing and brazing, our broad experience has indicated the best high temperature fabrication for each type of service. Our designs are simple and efficient, combining rugged strength with moderate weight.

Made from wrought material or in combination with alloy castings, in a variety of analyses to suit every practical condition, the construction of our welded-fabrications can be varied to suit operating conditions, whether the duty is normal or extremely severe. You are invited to consult with us on your high temperature needs. We offer practical, reliable service based on many years experience in this field. We will be pleased to quote from your own details or to offer suggestions on redesign of existing equipment.



Correctly fabricated in rolled alloys, our modern, sturdy, light-weight corrugated muffles deliver top performance. Every detail of their design and construction is carefully supervised to insure dependable service and long life.

ALLOY STEEL Fabrication Division
ALUMINUM and ARCHITECTURAL METALS COMPANY
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DESIGNERS AND PRODUCERS OF ALLOY STEEL AND NON-FERROUS METAL FABRICATIONS

Here's why you can have confidence in America's future!

Individual savings are at highest level ever—*$300 billion*—a record amount for available spending. There's a new wave of opportunity coming and smart people are getting ready for it.

(Continued from page 24)

mediately oxidized to water by the nitric acid, which is well known to be a strong oxidizing agent.

Sulphuric acid can be used either cold or hot in etch-crack studies. A satisfactory concentration is 15 per cent by volume of concentrated sulphuric acid in water. For all practical purposes, it is sufficiently accurate to pour slowly, with stirring, one part of the concentrated acid into five parts of water. It has been found that repeated use of the same batch of the cold etchant makes it act more vigorously. If, in a laboratory investigation, it is desired to keep the action as uniform as possible, 15 grams of ferrous sulphate ($FeSO_4.7H_2O$) should be added to one liter of the cold etchant, or two ounces per gallon.

With the sulphuric acid at room temperature, a 15-minute etch is generally sufficient to form etch cracks in hardened steel, if the ground surface is highly stressed. A longer time in the acid may be necessary if the stresses are not quite so high. Often, increasing the time will increase the amount of etch cracking, the reason being probably that progressively lower stresses are enabled to develop into etch cracks.

If the surface stresses are not high enough to result in etch cracks after prolonged exposure of the steel to the cold acid, etch cracks may still form, from somewhat lower stresses, if the steel is etched in the same acid heated to about 170°F. If etch cracks are not found after five or ten minutes in the hot acid, it is safe to say that they will never be formed.

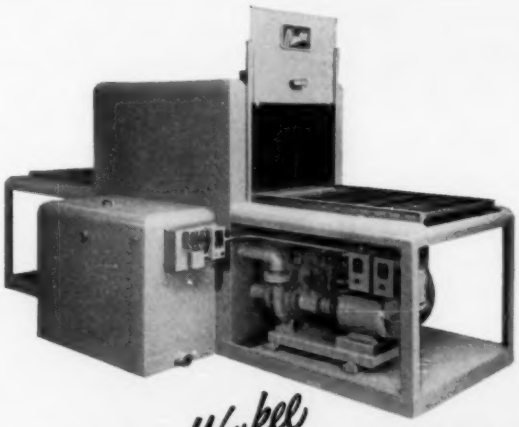
Hot hydrochloric acid, containing one part of the concentrated acid to one part of water, can be used in place of hot sulphuric acid with about the same effect. The former is widely used in connection with visual inspection of steel for numerous types of defects.

The appearance of individual etch cracks depends on the temperature and duration of the etch and on the steel. In some steels, a cold etch will result in such narrow cracks that the magnetic particle method has to be applied to make them visible, as is true, for example, of the etch cracks in Fig. 1. The width of the dark lines depends upon the quantity of magnetic particles deposited around the cracks. In other steels, cracks obtained under similar etching conditions are wide enough to be easily visible. The depth of etch cracks is not likely to be greater than 0.010" or 0.015", regardless of their width.

Etch-crack patterns in ground surfaces are the same as those characteristic of spontaneous surface cracks, which have already been described and illustrated. This is to be expected since the same stresses are essentially responsible for etch cracks as for spontaneous cracks, only the magnitude of the stresses being somewhat different in the two cases. Some typical etch-crack patterns, the result of a 15-minute cold etch, are shown in Fig. 1, where the pieces have been surface ground progressively more severely from left to right.

Only fairly high surface stresses in hardened steel are capable of be-

(Continued on page 45)



There's a standard Waukee® WASHER
TO MATCH YOUR CARBONITRIDER OR CARBURIZER!

Whatever the size of your carbonitrider or carburizer, the new Waukee Washer has a standard size to match it. Size range: 24 x 36 x 18 — 24 x 48 x 24 — 30 x 48 x 24 — 36 x 48 x 24.

COMPLETE — NO "EXTRAS" — Waukee parts washers come to you complete, ready to locate, connect to utilities, and begin operation. No "extras" to buy and install. Pumps, burners, controls are designed as integral parts of the Waukee Washer. You use your present furnace work-baskets, too.

FLEXIBILITY — You gain in flexibility with Waukee Washers. Standard units are available in "in-and-out" feed or straight-through, conveyor type, and in one, two, or three stages with rinse and dry. High-efficiency with gas, electricity, or steam.

THOROUGH CLEANING — The smallest Waukee Washer sprays a minimum of *one ton of hot detergent solution through the load each minute.* Solution penetrates work basket from top and bottom, washes away oil and foreign matter from the densest charge. Bull's-eye timer cycles the load for complete washing without guesswork or waste of time.

Complete data in Bulletin 1201 — write for it today.

Waukee-washed parts are free of cutting and quenching oils, mean clean furnace atmospheres, therefore predictable case depths and cleaner, brighter work.

Waukee ENGINEERING CO.

5137 N. 35TH ST., MILWAUKEE 9, WIS.

MAKERS OF WAUKEE GAS FLO-METERS • MIXORS • COMPRESSORS

NEWS TO HEAT TREATERS

(Continued from page 36)

HEAT TREATING WITH JIGS

Vertical pit-type furnaces and suspension jigs are enabling E&J Heat Treating, Inc., Los Angeles, to heat treat ferrous parts with lengths up to 14½' without distortion on a production basis.

Although the advantages of jigs are well known, heat treaters in general don't use special tooling for production work because the most practical jig materials simply won't stand up if repeatedly exposed to temperatures of 1000° to 2000° F and they feel it is most economical to straighten treated parts. But the best straightening facilities can't always restore critical dimensions or allow treated components to retain their most desirable physical properties.

E&J is able to avoid difficulties because there is a small section of

the uppermost working space in a modern vertical furnace that receives very little heat. Consequently, if parts are suspended from jigs which can be retained in the low temperature zone of the furnace, numerous treatments can be performed without damage to special tooling.

Materials heat treated by E&J include SAE 4130 and 4340, AM 350 and 355, and stainless and die steels.

The company uses both gas and electrically heated furnaces with controlled atmospheres. It is currently doing work for the aircraft, missile, rocket, oil tool, boat, shipbuilding, automotive, electronic, precision instrument, construction equipment, and farm implement industries.

For further information circle No. 21

EQUIPMENT FOR CONTRACT MANUFACTURE

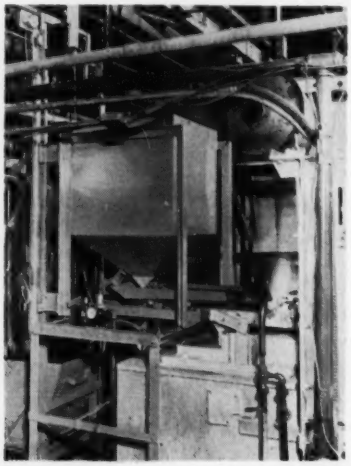
The Textile Machine Works, Reading, Pa., has just issued a new file folder listing the tools, equipment and facilities at the plant available for the manufacture of a wide variety of high precision parts, assemblies and complete machines for diversified industries. The folder is tabbed for easy reference. It lists and describes the following equipment: milling machines, lathes, boring machines, drills, grinders, slotting machines, planers, screw machines, broaching machines, shapers, power hammers, and equipment for sheet metal fabrication, gear manufacturing, *heat treating*, cleaning and finishing, testing, measuring, inspection, welding and forging, and specialized facilities such as marking and demagnetizing equipment.

Available through Textile, the brochure says, are more than one million square feet of manufacturing space, 1,200 machine tools and 3,000 skilled employees.

For further information circle No. 22

VIBRATORY FEEDER

A new line of air vibratory feeders has been developed by the Cleveland Vibrator Company, Cleveland, Ohio, featuring the even flow of locknuts to a carbonitriding furnace. Feed rate is about 200 pounds an hour at 25 pounds per square inch gage pressure.



The feeders are made of high-grade heat-resistant steel, making the hardening furnace application desirable since ambient temperature at the discharge end is 220° to 250° F. Air consumption is approximately 4.0 CFM of free air.

For further information circle No. 23

ZINC PLATE FINISH

Heatbath Corporation, Springfield, Mass., has introduced another new powdered chromate product known as Duracoat M-2-P for producing blue-bright, stain-resistant finishes on zinc plate at extremely low cost. Only one-half ounce of Duracoat M-2-P plus a small amount of nitric acid is required to make up one gallon of solution. No leaching is required. Low cost, long life and simple control are said to be the outstanding features of Duracoat M-2-P.

For further information circle No. 24

(Continued from page 43)

ing developed into etch cracks, even in hot acid. Somewhat lower surface stresses in strips that have been surface ground rather severely can distort these strips markedly; yet when the same strips are etched in hot sulphuric acid, etch cracks do not form. The relative magnitude of the surface stress can be estimated from the curvature of the strip.

For the sake of completeness, it is also well to mention two other methods that have been used in research work on surface stresses. One involves the use of a ring instead of a strip. After the ring is ground cylindrically, it is slotted parallel to its axis so that it can expand or contract depending upon the stresses that have been introduced in the grinding operation. The change in diameter of the ring is a measure of the magnitude of the stresses. In the second method, standard X-ray diffraction procedures are used to tell whether the atomic structure of the metal is squeezed together because of compressive forces or stretched out because of tensile forces.

With this background, the reader should be able to avoid misinterpreting his results when etching to detect surface cracks; and he should also be in a position to understand the references to surface stresses that he is likely to encounter in increasing number as more is learned about the practical significance of such stresses.

(To be continued)

FOR SALE AT BARGAIN!

200 INCONEL WIRE BASKETS—HEAVILY CONSTRUCTED. Sizes: 43¾" x 25¾" x 8" height, 44¼" x 25¼" x 8" height. Also have for sale 100 Separators measuring 44½" x 25". Basket price $50.00 each FOB Chicago.

ESTES MACHINERY COMPANY
114 South Clinton Street
Chicago 6, Illinois
Telephone: DEarborn 2-6595

MORE HEAT TREATING VOLUME
with BASIC "BUZZER PACKAGE"
NO BLOWER OR OTHER POWER NEEDED
. . . just connect to gas supply

"BUZZER" modern gas-fired heat treating and melting units give you the most dependable, economical and productive system for turning out quality jobs at low productions costs. When power is off—"BUZZER" stays on the job! Standard and special furnaces, large or small, available to equip your shop to exact requirements.

COMPLETE LINE OF BUZZER REG. U.S. PAT. OFFICE BURNERS FOR CLEANING, RINSING, PICKLING AND SUNDRY HEAT OPERATIONS

WRITE TODAY FOR NEW "BUZZER" CATALOG

CHARLES A. HONES, INC.
145 S. GRAND AVENUE, BALDWIN, L.I., N.Y. • BAldwin 3-1110
HEAT TREATING EQUIPMENT SPECIALISTS SINCE 1911

STOP SCALING, CARBURIZATION & DECARBURIZATION DURING HEAT TREATING

MARKAL "C-R" COATINGS protect against oxidation, corrosion, scaling, gas absorption, carburizing and decarburizing during heat-treating, annealing, normalizing or stress-relieving.

MARKAL "C-R" Coatings protect up to 2100° F. steel, stainless steel, copper, copper bronze, nickel bronze, titanium, zirconium, titanium and molybdenum alloys, inconel and monel metals during heat-treating.

MARKAL "C-R" Coatings can be removed easily from surface after operation is completed, in most instances.

Write on company letterhead for complete information. Engineering service available for special problems.

The Mark of Quality . . . MARKAL Protective Coatings

MARKAL COMPANY 3102 West Carroll Avenue, Chicago 12, Illinois

MANUFACTURERS' LITERATURE

For your copy circle the number on the Readers' Service Card

HEAT TREATING AND METALLURGY AS A CAREER

The opportunities offered by industry to young people choosing a career in heat treating and metallurgy are described by Anthony T. Journalist of The Barden Corp., Danbury, Conn., in a revised career booklet now available.

More than 170,000 copies of this publication have been distributed to secondary schools in the past five years by Connecticut's four major electric utilities as an educational undertaking.

For further information circle No. 7

PEARLITIC MALLEABLE CASTINGS

Malleable Research and Development Foundation, Granville, Ohio, is offering a 76-page handbook giving an introduction to pearlitic malleable, as well as a ready reference to the latest information and data on this relatively new material. The book includes 10 tables, 19 charts, and 14 illustrations, and is offered to anyone responsible for materials specification or selection.

For further information circle No. 8

HEAT RESISTING ALLOYS

Rolled Alloys, Inc., Detroit, Mich., has published a 6-page bulletin *Information on RA 330* suitable for reference filing.

The latest data on RA 330 heat resisting alloys is included as well as valuable information on chemical composition, stress rupture properties, short-time, high-temperature properties, oxidation resistance and recommended design stresses.

For further information circle No. 9

HIGH-TEMPERATURE CONVEYORS

Designs and dimensions for three new high-temperature vibrating conveyors manufactured by Carrier Conveyor Corporation, Louisville, Ky., are detailed in the company's new catalog.

Each of these conveyors can handle hot materials up to 1800°F by means of controlled trough expansion and double trough design. All conveyor troughs are installed in overlapping 5' lengths.

For further information circle No. 10

HIGH-VACUUM PUMPS

The Kinney Mfg. Division of The New York Air Brake Co., Boston, Mass., has published a technical bulletin which illustrates and describes their Mechanical Booster High-Vacuum pumps.

These pumps are said to feature high pumping speed in the low micron range and their design allows for the addition of interstage cold traps with a minimum of complications.

For further information circle No. 11

QUENCHING OIL DATA

The Sinclair Refining Company, New York, N. Y., has published a 12-page illustrated technical bulletin entitled *Sinclair Quenchol (500 Series)* explaining a new concept in quenching oil.

The bulletin maintains that the use of the various quenching oils in this new series assures performance results heretofore unobtainable in conventional quenching operations. All plants using a quenching operation are urged to make a comparison between products now in use and this new Sinclair quenching oil on such items as degree and uniformity of hardness, distortion and warpage, oil evaporation and drag-off, and oil breakdown due to sludging.

The bulletin also gives important schematic diagrams and graphs together with important illustrations and tables explaining in detail this new quenching oil.

For further information circle No. 12

STAINLESS STEEL PROCESSING

The American Gas Furnace Company, Elizabeth, N. J., has published a 4-page illustrated brochure describing its main line of furnaces for processing stainless steel.

The bulletin illustrates and describes AGF's shaker hearth furnaces for bright annealing and hardening at temperatures up to 2000°F; its push-through muffle furnaces for bright brazing, annealing, and hardening at temperatures up to 2000°F; 2100°F; its bell retort furnaces for bright annealing at temperatures from 400°F-2150°F; and the cartype bell retort furnaces for large capacity batch-type stainless processing.

For further information circle No. 13

ELECTRIC FURNACE

Design features of the Type LAC-50M conveyor heat treating furnace, a compact production unit for alloying transistors and diodes, for metal bonding and soldering, and similar applications are described in a bulletin issued by C. I. Hayes, Inc., Cranston, R. I.

Three-zone temperature control within the heating chamber makes it possible to obtain an exact temperature curve (through a 500°-1100° C range) for the particular work being processed. Integral equipment provides pure, dry processing atmosphere while an electronic DC drive provides belt speed control.

For further information circle No. 14

HEAT TREATING FURNACES AND OVENS

A new, complete, illustrated 40-page catalog has recently been published by the K. H. Huppert Co., Chicago, Ill.

The company is a manufacturer of electric heat treating and laboratory furnaces and ovens. It also builds furnaces to order and manu-

factures a line of thermocouples and pyrometers. A supplement included at the end of this catalog is a 4-page, illustrated article entitled "Hints on Heat Treating Tool Steel."

For further information circle No. 15

VACUUM METALLURGY

A new book providing the engineering field with a complete, up-to-date reference on vacuum metallurgy has just been published by the Reinhold Publishing Corp. The book is entitled *Vacuum Metallurgy* and is edited by Rointan F. Bunshah, Associate Research Scientist, College of Engineering, New York University, New York, N. Y.

During June, 1957, the Department of Metallurgical Engineering of NYU College of Engineering sponsored a one-week course in Vacuum Metallurgy. The course consisted of 27 lectures by experts in all phases of the subject. All of the lectures were then collected, edited, and published for the first time in November, 1958.

The book encompasses virtually the entire field — production and measurement of vacuum; vacuum melting techniques; degassing of metals; and the metallurgical applications of vacuum processes to powdered and electronic materials, coatings, and high-temperature alloys.

The 472-page book sells for $12.50 and has particular importance to the missile, aircraft, atomic energy and electronics industries, or wherever high quality material processed by vacuum processing is needed.

Please write directly to Reinhold Publishing Corp., 430 Park Avenue, New York 22, N. Y.

MAINTENANCE OF REFRACTORY STRUCTURES

A new issue of a bi-monthly bulletin entitled "Refractories By Carborundum," and published by the Refractories Division of The Carborundum Company, Perth Amboy, N. J., is now available.

This 8-page illustrated issue features a very important discussion on the general subject of maintenance of refractory structures. The role of maintenance as a cost-control tool is discussed at length in its applications to many types of industrial equipment.

For further information circle No. 16

DEWTRONIK-CARBOTRONIK

Modern methods of maintaining accurate automatic control of dewpoint and/or carbon potential in endothermic type atmospheres for clean, scale-free or bright carburizing or carbonitriding of steel parts is discussed in a two-page technical bulletin, "Ipsen Dewtronik and Carbotronik."

The bulletin describes how both the Dewtronik and Carbotronik instruments work, and tells how atmosphere dewpoint or potential is controlled. Also shown is a circuit diagram as well as a specification table which includes overall dimensions and shipping weights.

For further information circle No. 17

REGULATOR CATALOG

Oxweld industrial gas regulators are described and illustrated in a twenty-page catalog available from Linde Company, Division of Union Carbide Corporation. This comprehensive catalog includes complete specifications and ordering information for 47 Oxweld regulators that are available for use with all industrial gases.

For further information circle No. 18

(Continued on page 52)

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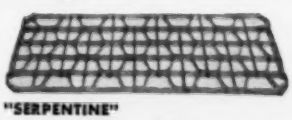
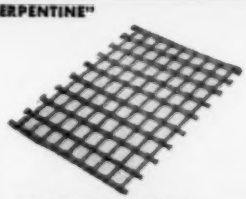
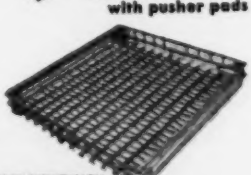


"SERPENTINE"



"PRESSURE WELDED" Furnished 2-layer or 3-layer

"PRESSURE WELDED" with pusher pads



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(Continued from page 35)

Table I

EQUIVALENT COST OF GAS AT VARIOUS EFFICIENCIES *VS.* ELECTRICAL ENERGY AT 100% EFFICIENCY

APPROX. 600° F		APPROX. 1200° F		APPROX. 1600° F		APPROX. 2200° F	
Elec. Cost Per KWH 100% Eff.	Gas Cost Per Therm. 80% Eff.	Elec. Cost Per KWH 100% Eff.	Gas Cost Per Therm. 65% Eff.	Elec. Cost Per KWH 100% Eff.	Gas Cost Per Therm. 55% Eff.	Elec. Cost Per KWH 100% Eff.	Gas Cost Per Therm. 45% Eff.
$0.0026	$0.06	$0.0032	$0.06	$0.0037	$0.06	$0.0046	$0.06
.0030	.07	.0037	.07	.0043	.07	.0053	.07
.0034	.08	.0042	.08	.0050	.08	.0061	.08
.0038	.09	.0047	.09	.0056	.09	.0068	.09
.0043	.10	.0053	.10	.0062	.10	.0076	.10
.0047	.11	.0058	.11	.0068	.11	.0084	.11
.0051	.12	.0063	.12	.0075	.12	.0091	.12
.0056	.13	.0068	.13	.0081	.13	.0099	.13
.0060	.14	.0074	.14	.0087	.14	.0106	.14
.0064	.15	.0079	.15	.0093	.15	.0114	.15
.0068	.16	.0084	.16	.0100	.16	.0122	.16
.0073	.17	.0089	.17	.0106	.17	.0129	.17

Explanation—At various temperatures, gas efficiencies change because of heat lost in the flue products—see separate tabulation of "available heat". For example, if one intends to work at about 1600°, gas efficiency can only be 55% with usual means. At this efficiency, if one can buy gas for 10¢ per therm (100,000 BTU), to equal the cost in electricity, one would need a rate as low as 6/10 cents per KWH.

Efficiency and Fuel Cost: See Table I. Although a great deal of gas heat is lost through the flue products, the cost of gas, especially in the Midwest, runs from one-quarter to one-half the cost of electric power even allowing for such a loss. Demand charges are also an influence.

Work Quality: Should be equal, depending upon selection of the proper unit.

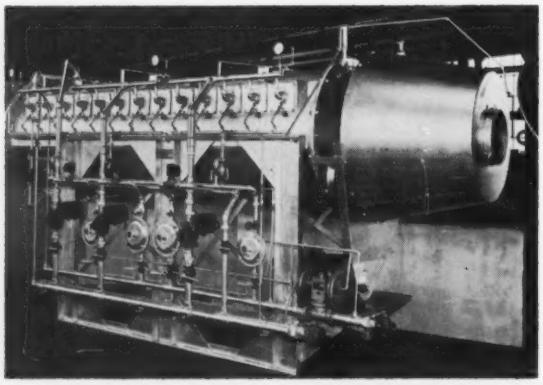


Fig. 6—This gas-fired, continuous, rotary retort machine with loading hopper occupies a floor space about 5' wide by 16' long, with a heated retort 14" i.d. by 10' long, but produces up to 800 pounds per hour of heated work with a maximum input available of about 900,000 BTU per hour.

Producing Capacity: In direct-fired and muffle-type furnaces, experience indicates an ability of gas-fired units to produce more work per unit of hearth area, although this is apparently not so in the case of radiant tubes. This possible advantage is probably because it is easy to change burner heat capacity to the optimum or surplus with great flexibility. The convection heat transfer created by the burning and moving gases also gives direct-fired gas an advantage.

Controllability: Either method of heating is regularly and easily controlled, but most gas units can be throttled and thus used on true proportional control. In gas work, the maximum and minimum input are also easily changed, whereas in electric or gas radiant tubes it is all "on" or "off". Gas valves can be made to float, and a slow or fast high-low or off arrangement is possible, as desired. It is also easier with gas to balance temperature in various parts of a furnace, burner sizes being changed in minutes.

Venting: Here, electric has a distinct advantage of varying degree. However, electric units must also have vents for atmosphere, for smoke from the work and for fumes from the quench.

Worker Comfort: Generally speaking, if both types of units are equally and properly insulated, there is

Table II

AVAILABLE HEAT IN GAS AT VARIOUS TEMPERATURES:—BASED ON 1000-1060 BTU NATURAL GAS

Temp.	Av. BTU	% Eff.	Temp.	Av. BTU	% Eff.	Temp.	Av. BTU	% Eff.
600°F	820	78	1200°F	690	65	1800°F	540	51
700°	800	76	1300°	670	64	1900°	515	49
800°	775	74	1400°	640	61	2000°	500	48
900°	750	71	1500°	610	58	2100°	480	46
1000°	730	70	1600°	590	56	2200°	450	43
1100°	710	68	1700°	570	54	2300°	420	40

little difference on this point. However, with the less expensive fuel, there is less tendency to insulate gas units. Burner castings, manifolding and vent lines usually give off enough heat to conclude that electric heat has the advantage here. However, there are also certain heat losses at entrance and exit, such as vestibules, etc.

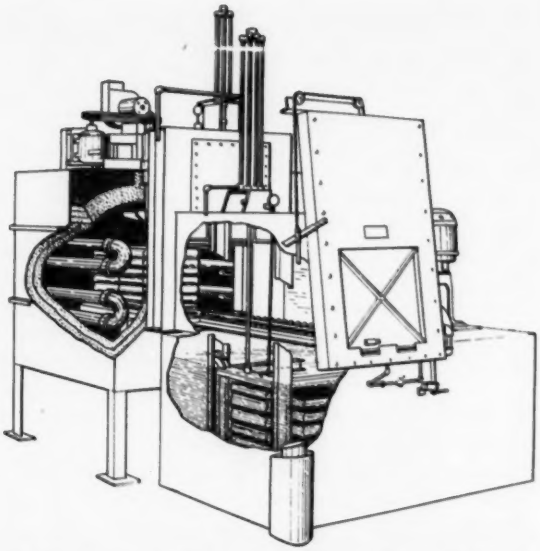


Fig. 7—Where muffles are impractical, gas-fired, radiant tubes permit full atmosphere control as in this mechanized elevator quench unit. (Courtesy Surface Combustion Corp.)

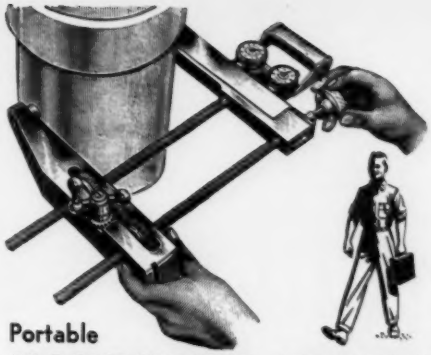
Operator Skill Required: Modern gas furnaces reduce to a minimum the judgment and skill required of an operator, but there is no doubt that it is easier to throw a switch on an electric furnace.

Space: For a given work area, electric furnaces require slightly less floor space than gas furnaces.

Muffles, etc.: In atmosphere furnaces, when the atmosphere does not harm the elements, especially at higher temperatures as in copper brazing, electricity has a great advantage because muffles are not needed. Muffles in gas furnaces are limited in size and temperature; however, gas-fired radiant tubes compete with electricity at temperatures of 1850° F or below when furnace sizes are too great for muffles. However, in stainless work, brazing, hardening and annealing, a metal muffle must be used in every case because the refractory retains moisture. Also, in ammonia gas carburizing, it takes considerable time to get the traces of NH_3 out of the brick. In vacuum heat treating, where a partial vacuum must be maintained outside a metal muffle, electricity is the only choice, although some vacuum units have been built as gas-fired with thick, strong muffles.

Effect of Atmosphere on Elements: Much greater care must be taken as to what foreign materials are on the work in the case of an electric furnace. Certain carbonaceous atmospheres and those containing sul-

(Continued on page 50)



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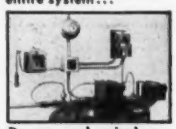
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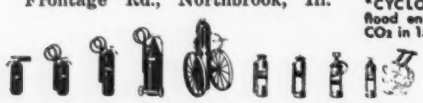

(Continued from page 49)

phur from machining lubricants, etc., have a decidedly deleterious effect. Such foreign materials have little or no effect on gas burners.

Temperatures: Either fuel easily accomplishes the usual ranges, but in the higher ranges the resistors must be protected by atmosphere if they are metal, whereas in ranges of 2800°-3000° F no very special measures are necessary on gas-fired units.

Ruggedness: On certain electric furnaces, care must be exercised to avoid disturbing or contacting the elements during use or loading. The refractory area near the elements must be kept in good condition. Gas units can be operated under much more adverse conditions in various states of repair.

Noise: Some gas units are noisy and some are quieter, but electric heat is noiseless.

Accessory Equipment: In electric equipment, the cost of lines, transformers, etc., should never be omitted from consideration. In gas units, a blower or mixing machine and vent blowers may be needed. Concerning this, a 1 hp. blower delivering 85 CFM air will provide combustion air for 510 CFH of natural gas. Figured at 2¢ per KWH, this would add only 3/10 cents to the cost of a therm (100,000 BTU) of gas.

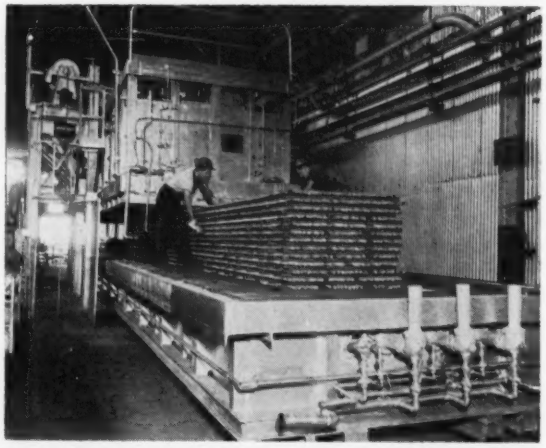

Fig. 8—Gas-fired, radiant tubes heat this large elevator car-bottom, atmosphere annealing furnace. (Courtesy Surface Combustion Corp.)

Summary

As we have seen, there can be many specific reasons for a choice of one type of heat over another, but at the present time the economies seem to be overwhelmingly in favor of gas except in certain industries where sometimes, for unexplained reasons, electricity is preferred. Incidentally, this seems to be especially so in the aircraft industries associated with or operated under the specific jurisdiction of the government.

It may well be that electric power, perhaps nuclear generated, will eventually be our prime source; but until electricity becomes much less expensive in relation to gas, gas will remain the general choice for the greatest economy. • • •

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HOLCROFT Radiant Tube Carburizing Furnace, Gas Fired, 48" x 18" opening. 25' long heat zone, 3 zone temperature control with L & N strip chart recording controllers, hydraulic doors & work pushers, oil quench pit with hoist and conveyors.

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HOLDEN #202 Salt Bath Furnace, 300° to 1850° F. 1000# per hour at 1050°. 60" long x 36" wide x 48" deep steel pot. Model HEL60D 3646S; 125 KVA transformer. 460 V primary, 12-24 V low voltage.

3-ECLIPSE Air Draw Furnaces, Model 7AD-35; S/N's 40218, 40219, 40176; 36" dia. x 56" deep; Complete with Micromax recording controller; Gas fired with necessary controls and safety equipment, 1000° F. max. Temperature.

2-LEEDS & NORTHRUP 100 KW "Homocarb" Furnaces; Model 9775-36-10S; S/N 405461; 40" dia. x 10 ft. deep; Complete with air cooled transformer, motor operated furnace cover and L & N strip chart controller; 1800° F. max. temperature.

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HAYES Electric Globar Metallurgical Laboratory Test Furnace, Horizontal Type HGF-101, 40 KW, 220V, 105 amps, 3 phase, 60 cycle, double entrance, 2" clearance, each entrance 14" x 24" x 2", 55¼" wide, 39½" long, 75" high, 4 steel legs. G. E. Atmosphere converter, Clark Controller, Brown Potentiometer.

HEVI-DUTY 18 KW Pot Type Furnace, 12" dia. x 18" deep; 1250° work temp.

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200-INCONEL Wire Heat Treating Baskets; 25" wide x 45" long x 8" deep.

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MANUFACTURERS' LITERATURE

(Continued from page 47)

ALLOY STEELS BOOK

A new booklet "The Eight Steps To Risk-Proof Alloy Steels," explains how a special 8-point plan of Joseph T. Ryerson & Son Inc., Chicago, goes beyond normal precautions to give added protection to buyers of alloy steel. The program in effect is said to remove the uncertainties over mechanical properties that may be obtained; and to lessen or eliminate the need for users to set up their own costly and time-consuming checks and tests. Key to customer benefits is the Ryerson Certificate of Analysis and Hardenability which accompanies every shipment, and which is reproduced in the booklet along with an explanation of the end-quench hardenability test that is given all as-rolled and annealed alloy steel selected for Ryerson stocks.

For further information circle No. 19

FACT-BOOK ON ULTRASONIC CLEANING

"Ultrasonic Cleaning", a new illustrated 24-page booklet based on 12 years of experience in the field, is now available from Branson Ultrasonic Corporation, Stamford, Conn. The bulletin explains practical applications and basic principles of this modern cleaning method, as well as design of equipment.

Many areas in which ultrasonic cleaning is advantageous are covered in some detail. For example, the automotive, aircraft, hardware, metalworking, and electrical fields find the speed of ultrasonic cleaning a prime factor. In electronics, optical equipment, plating, jewelry, atomic energy, and surgical or high-precision instruments, thoroughness of soil removal is considered most important. For others, concerned with intricate mechanisms, electronic chassis, and salvaging, the ability to clean without disassembly is the main reason for use.

Design information occupies a large part of the booklet. Under general system considerations, batch immersion, conveyor and multistage systems are discussed, along with various transducer arrangements. Information on solutions and chemicals recommended for ultrasonic cleaning is also included.

The section on cleaning principles explains that ultrasonic energy creates cavitation in the liquid. Cavitation is the rapid generation and sudden, violent collapse of very small bubbles throughout the solution. These bubbles act like thousands of scrub brushes at all surfaces in contact with the liquid, so that complicated shapes, blind holes, and crevices are cleaned as completely as simple surfaces.

For further information circle No. 20

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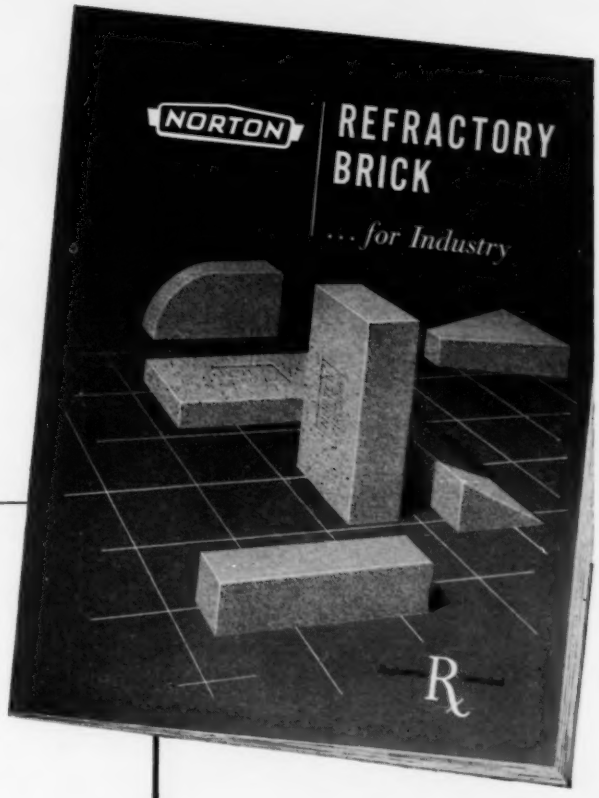

Covers Norton refractory brick applications, characteristics, chemical analyses — includes helpful data on materials of construction for temperatures up to 4,400°F.

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All essential details are listed, such as: how each material is produced . . . important properties, characteristics and chemical analyses . . . shapes of brick and other molded products that are available . . . representative applications . . . packing methods that assure safe arrival.

Also included are charts and tables of brick shapes and sizes, thermal expansion and conductivity graphs, and a temperature conversion chart.

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1018 Buchanan Street
Rockford, Illinois

INTERNATIONAL NICKEL CO., INC
67 Wall Street
New York 5, New York

RANDOLPH LABORATORIES, INC.
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Northbrook, Illinois

ROLOCK, INC.
1232 Kings Highway
Fairfield, Connecticut

STANWOOD CORPORATION
4825 West Cortland Street
Chicago 39, Illinois

WIRETEX MFG. CO., INC.
16 Mason Street
Bridgeport 5, Connecticut

FLAME HARDENING

CINCINNATI MILLING MACHINE COMPANY
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Cincinnati 9, Ohio

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Dresher, Pennsylvania

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AMERICAN GAS FURNACE CO.
808 Lafayette Street
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SELAS CORPORATION OF AMERICA
Dresher, Pennsylvania

WAUKEE ENGINEERING CO.
5137 North 35th Street
Milwaukee 9, Wisconsin

FURNACES

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Elizabeth, New Jersey

ECLIPSE FUEL ENGINEERING CO.
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Rockford, Illinois

C. I. HAYES, INC.
816 Wellington Avenue
Cranston 10, Rhode Island

HEVI-DUTY ELECTRIC CO.
P. O. Box 563
Milwaukee 1, Wisconsin

THE A. F. HOLDEN COMPANY
14341 Schaefer Highway
Detroit 27, Michigan

CHARLES A. HONES, INC.
Baldwin, L. I., N. Y.

IPSEN INDUSTRIES, INC.
715 South Main Street
Rockford, Illinois

LINDBERG ENGINEERING COMPANY
2466 West Hubbard Street
Chicago 12, Illinois

PACIFIC SCIENTIFIC COMPANY
P. O. Box 22019
Los Angeles 22, California

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Dresher, Pennsylvania

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Meadville, Pennsylvania

SURFACE COMBUSTION CORPORATION
HEAT TREAT DIVISION
Toledo 1, Ohio

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Philadelphia 23, Pennsylvania

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808 Lafayette Street
Elizabeth, New Jersey

ECLIPSE FUEL ENGINEERING CO.
1018 Buchanan Street
Rockford, Illinois

HEVI-DUTY ELECTRIC CO.
P. O. Box 563
Milwaukee 1, Wisconsin

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Detroit 27, Michigan

CHARLES A. HONES, INC.
Baldwin, L. I., N. Y.

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Meadville, Pennsylvania

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Cranston 10, Rhode Island

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Milwaukee 1, Wisconsin

IPSEN INDUSTRIES, INC.
715 South Main Street
Rockford, Illinois

NEW YORK AIR BRAKE COMPANY
KINNEY MFG. DIVISION
3594B Washington Street
Boston 30, Massachusetts

PACIFIC SCIENTIFIC COMPANY
P. O. Box 22019
Los Angeles 22, California

GAS BURNERS & TORCHES

CHARLES A. HONES, INC.
Baldwin, L. I., N. Y.

GAS GENERATORS

AMERICAN GAS FURNACE CO.
808 Lafayette Street
Elizabeth, New Jersey

C. I. HAYES, INC.
816 Wellington Avenue
Cranston 10, Rhode Island

EQUIPMENT AND MATERIALS DIRECTORY *(Continued)*

HEVI-DUTY ELECTRIC CO.
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Milwaukee 1, Wisconsin

IPSEN INDUSTRIES, INC.
715 South Main Street
Rockford, Illinois

LINDBERG ENGINEERING COMPANY
2466 West Hubbard Street
Chicago 12, Illinois

PACIFIC SCIENTIFIC COMPANY
P. O. Box 22019
Los Angeles 22, California

SUNBEAM EQUIPMENT CORPORATION
180 Mercer Street
Meadville, Pennsylvania

SURFACE COMBUSTION CORPORATION
HEAT TREAT DIVISION
Toledo 1, Ohio

GAS MIXING EQUIPMENT

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5137 North 35th Street
Milwaukee 9, Wisconsin

GASES

ARMOUR AMMONIA DIVISION
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Chicago, Illinois

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WILSON MECHANICAL INSTRUMENT DIV.
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230 Park Avenue
New York 17, New York

STEEL CITY TESTING MACHINES, INC.
8805 Lyndon Avenue
Detroit 38, Michigan

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(Non-Metallic)

NORTON COMPANY
Worcester 6, Massachusetts

HIGH TEMPERATURE FANS

GARDEN CITY FAN COMPANY
801 North Eighth Street
Niles, Michigan

METAL FINISHING

HEATBATH CORPORATION
P. O. Box 78
Springfield 1, Massachusetts

THE A. F. HOLDEN COMPANY
14341 Schaefer Highway
Detroit 27, Michigan

NITRIDING

THE A. F. HOLDEN COMPANY
14341 Schaefer Highway
Detroit 27, Michigan

PROTECTIVE COATINGS

MARKAL COMPANY
3052 W. Carroll Avenue
Chicago 12, Illinois

PARK CHEMICAL COMPANY
8076 Military Avenue
Detroit 4, Michigan

QUENCHING OILS

GULF OIL CORPORATION
Gulf Building
Pittsburgh, Pa.

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Detroit 27, Michigan

E. F. HOUGHTON & CO.
303 West Lehigh Avenue
Philadelphia 33, Pennsylvania

PARK CHEMICAL COMPANY
8076 Military Avenue
Detroit 4, Michigan

SINCLAIR REFINING COMPANY
600 Fifth Avenue
New York, New York

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Worcester 6, Massachusetts

SALTS (Heat Treating)

AMERICAN CYANAMID COMPANY
PROCESS CHEMICALS DEPARTMENT
30 Rockefeller Plaza
New York 20, New York

HEATBATH CORPORATION
P. O. Box 78
Springfield 1, Massachusetts

THE A. F. HOLDEN CO.
14341 Schaefer Highway
Detroit 27, Michigan

E. F. HOUGHTON & CO.
303 West Lehigh Avenue
Philadelphia 33, Pennsylvania

PARK CHEMICAL COMPANY
8076 Military Avenue
Detroit 4, Michigan

SPECIAL CONTROL EQUIPMENT

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Philadelphia 23, Pennsylvania

THE HERSCOTT CO., INC.
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Rockford, Illinois

IPSEN INDUSTRIES, INC.
715 South Main Street
Rockford, Illinois

RANDOLPH LABORATORIES, INC.
1454 Frontage Road
Northbrook, Illinois

STRAIGHTENING EQUIPMENT

BLAW-KNOX COMPANY
NATIONAL ALLOY DIVISION
Pittsburgh 38, Pennsylvania

GENERAL MANUFACTURING COMPANY
6426 Farnsworth Avenue
Detroit 11, Michigan

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MARKAL COMPANY
3102 West Carroll Avenue
Chicago 12, Illinois

WEST INSTRUMENT CORPORATION
4363 West Montrose
Chicago 41, Illinois

TESTING EQUIPMENT

PACIFIC SCIENTIFIC COMPANY
P. O. Box 22019
Los Angeles 22, California

RIEHLE TESTING MACHINES DIVISION
AMERICAN MACHINE AND METALS, INC.
East Moline, Illinois

STEEL CITY TESTING MACHINES, INC.
8805 Lyndon Avenue
Detroit 38, Michigan

WILSON MECHANICAL INSTRUMENT DIV.
AMERICAN CHAIN & CABLE COMPANY, INC.
230 Park Avenue
New York 17, New York

TOOL STEELS

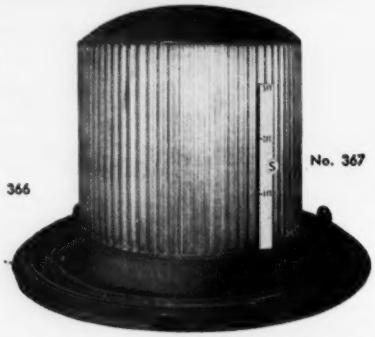
BETHLEHEM STEEL COMPANY
Bethlehem, Pennsylvania

HEAT TREATING EQUIPMENT

Two new COR-WAL Vertical Furnace Hoods by STANWOOD

- LIGHTER WEIGHT, YET GREATER STRENGTH
- LESS DISTORTION AT HIGH TEMPERATURES

No. 366



No. 367

These new Cor-Wal Furnace Hoods are real cost-cutters—will stay in severe service longer, give top performance at extremely high temperatures. Made of Stanwood's exclusive, heat and corrosion resistant corrugated rolled alloy. Send for the Cor-Wal story! Stanwood Corporation, 4825 West Cortland Street, Chicago 39, Illinois.

CONSULT THE STANWOOD SALES ENGINEER IN YOUR AREA!

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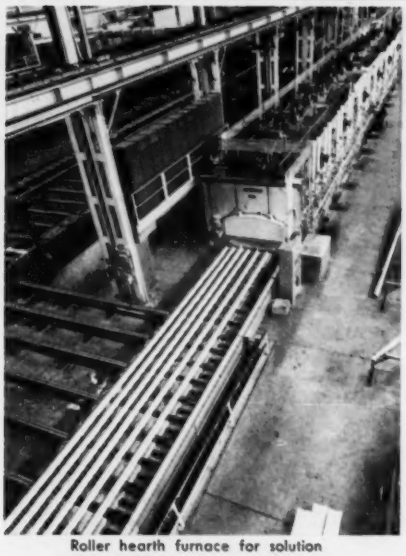
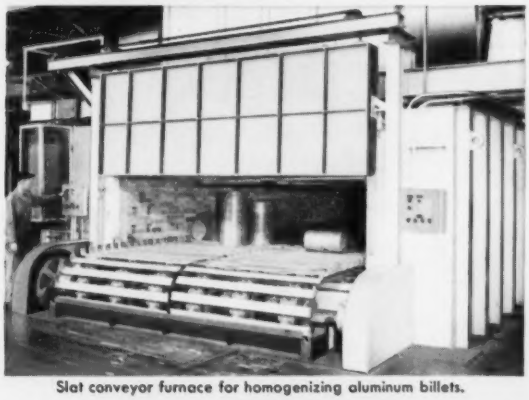
Sunbeam
FURNACES for ALUMINUM

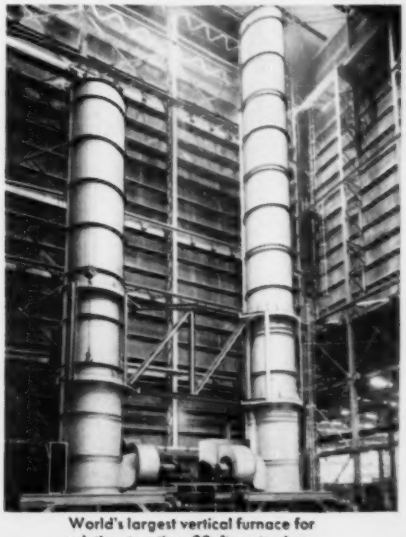


Roller hearth furnace for solution treating 50 ft. aluminum extrusions.

Car type furnace for homogenizing aluminum billets.



Slat conveyor furnace for homogenizing aluminum billets.



World's largest vertical furnace for solution treating 80 ft. extrusions.

Keeping pace with the technical needs of its customers has made Sunbeam Equipment Corporation a leader in the rapidly expanding aluminum field. Sunbeam is proud of the part it has played in the design and construction of furnaces to meet the most exacting specifications of an industry with such a bright future.

Sunbeam engineers are prepared to work in close harmony with your Engineering Department in analyzing your needs and in designing the furnace built to do a specific job. When your company has a heat processing problem that involves a single furnace or an entire production line...

SEE SUNBEAM FIRST

Our representatives are located in all principal cities in the United States, Canada and Mexico. Write today for the name of the one nearest you.

Sunbeam

Sunbeam **EQUIPMENT CORPORATION**

Dept. 257 180 Mercer Street Meadville, Penna.

CHANGE AJAX SALT BATH SUBMERGED ELECTRODES

. . . almost as fast as you'd change a tire!

✓ in about an hour per pair ✓ often while the salt remains molten

✓ without tearing down either furnace or pot

1

A closely fitted but readily removable tile block on top of the furnace seals the new Ajax removable submerged electrodes from air. Electrodes are exposed for easy replacement just by lifting the tile. No skilled labor is needed.

2

Electrodes enter furnace from the top and slant into the bath. There are no furnace openings whatever below the salt line. And there is no need to tear down any part of furnace or pot in changing electrodes!

3

Lift old electrodes out from the top . . . make replacements in about an hour per pair. In many cases, the job can be done while the salt bath remains molten, without even shutting the furnace down.

AJAX

HULTGREN

SALT BATH FURNACES

Internally heated–Electric and gas-fired types.

AJAX ELECTRIC COMPANY
940 Frankford Avenue
Philadelphia 23, Pa.

No more lost production time when salt bath electrode changes are necessary! This revolutionary Ajax design development reduces the job to a matter of minutes . . . and reduces maintenance costs accordingly. Moreover, pot life is vastly increased because the pot is no longer torn down in the electrode changing process. Equally important, although Ajax Removable Submerged Electrodes are made of non-critical materials, their life materially exceeds that of nickel alloy electrodes of conventional design.

Write for Ajax Bulletin 810

Associates: Ajax Engineering Corp., Ajax Electrothermic Corp.

AJAX HAS THE ANSWERS TO SALT BATH HEAT TREATING PROBLEMS!